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South Dakota Farm and Home Research

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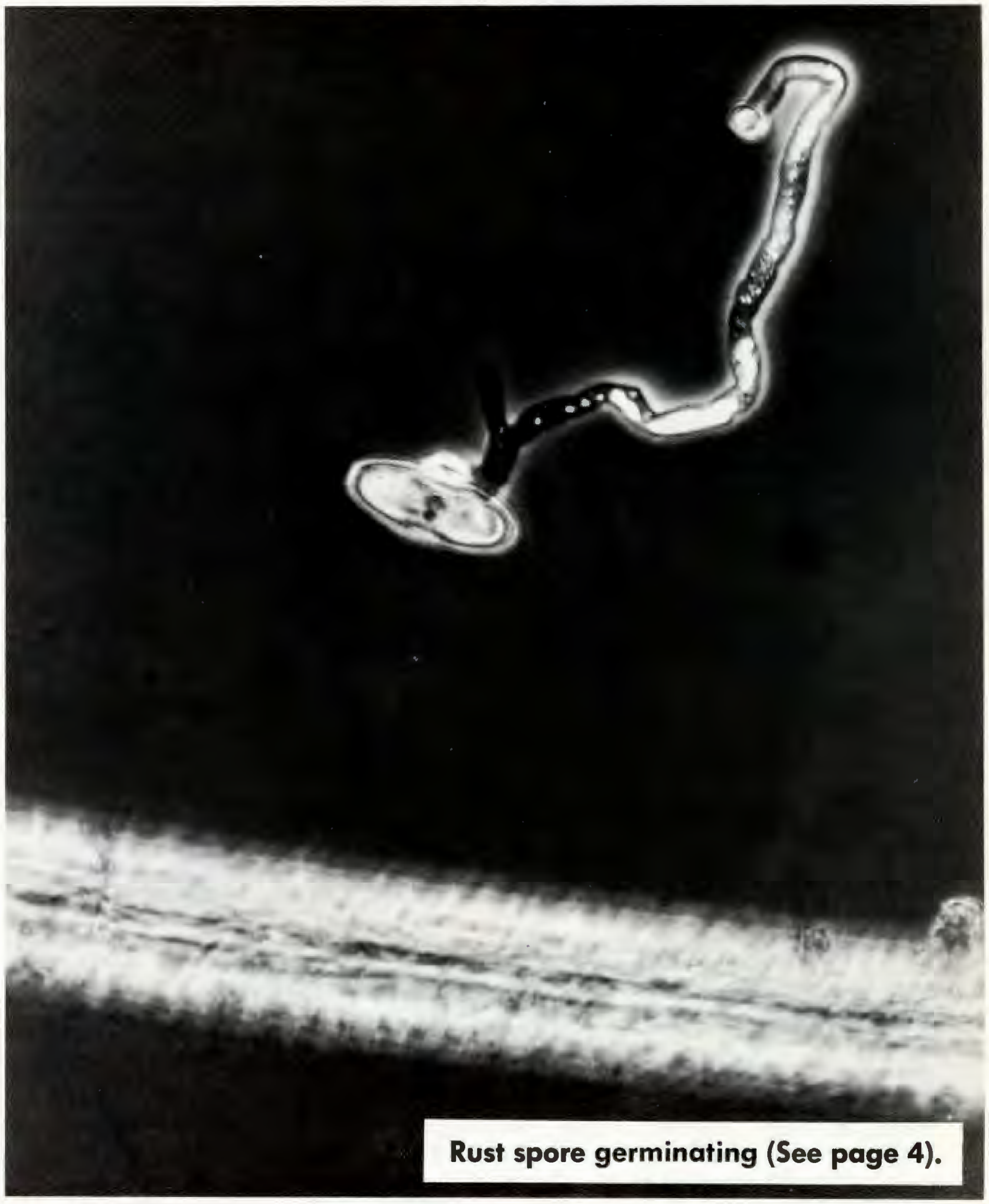
South Dakota
FARM & HOME RESEARCH



Rust spore germinating (See page 4).

Agricultural Experiment Station
SOUTH DAKOTA STATE UNIVERSITY
Brookings, South Dakota

Duane Acker

From the Dean and Director

South Dakota's agriculture presents both opportunities and challenges to the Agricultural Experiment Station. By firmly taking advantage of opportunities and meeting challenges head on, the Station will continue to provide a service of great value to all South Dakotans.

As the new director of the Station, I am gradually becoming acquainted with the resources, characteristics, and needs of the state.

In my brief exposure to South Dakota, six major items have impressed me as warranting emphasis in our research and educational efforts at South Dakota State University and at our substations throughout the state. These six are:

MANAGEMENT

Much of our teaching and research effort will be directed toward improving the ability of managers to make profitable decisions. There is considerable range in management capacity among the 50,000 farm operators in the state. A recent analysis of 53 South Dakota farms discloses a significant contrast between the high-profit and low-profit farms. Measures of efficiency for 15 low-profit and 15 high-profit farms in this group may be summarized as follows:

	15 Low-profit	15 High-profit
Power and Machinery Costs, $/crop Acre	11.65	8.77
Crop Acre/man	207	342
Pigs/litter	5.5	7
Lamb crop, per cent	78	93
Return/$100 feed to hogs	175.00	218.00
Return/$100 feed to beef	140.00	233.00

Similar data from other states shows that the response to capable management is greater in more intensive farming operations — in other words, in those enterprises which are more complex such as feeding cattle or raising corn. This contrast in profitability between high-profit and low-profit farms is greater than in enterprises less complex such as raising wheat or grazing cattle. Benefits of capable management will become more obvious as South Dakota moves toward a more intensive farming system with more acres and higher capital investment per farm, irrigation, higher plant populations, more dollar investment per crop acre and more livestock feeding.

WATER

In producing feed grains or grass we need soil, water, nutrients, sunshine, and carbon dioxide. In South Dakota water is the significant limiting resource. Average corn yield in South Dakota dropped from 48 bushels per acre in 1963 to 31 bushels per acre in 1964. The main cause: less water at critical times. Further, in 1964 only 70% of the corn planted in the state was

SOUTH DAKOTA STATE UNIVERSITY--"SERVING THE PEOPLE OF SOUTH DAKOTA THROUGH TEACHING, RESEARCH, EXTENSION."

SOUTH DAKOTA FARM AND HOME RESEARCH

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A Report of Progress

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To simplify terminology, trade names of products or equipment are sometimes used. No endorsement of specific products named is intended, nor is criticism implied of products not mentioned.

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Duane C. Acker, Dean of Agriculture and Director, Agricultural Experiment Station

Frank J. Shideler.........**Editor**

Leland L. Sudlow.........**Photographer**

Nathanial S. Cole.........**(Cover)**

harvested for grain. According to the Crop and Livestock Reporting Service, the following contrast in yield between nonirrigated and irrigated land occurred in South Dakota in 1963: (These are state averages in a "relatively good" crop year.)

	Nonirrigated	Irrigated
Corn (bu.)	48	73.5
Sorghum (bu.)	44	56
Wheat (bu.)	15	22
Oats (bu.)	35	49
Barley (bu.)	25	43
Alfalfa (T.)	1.6	2.7

FERTILIZER

Soil fertility is a limiting factor state-wide in crop production. Fertility can be made adequate, though, by use of commercial fertilizers in addition to legumes and manure. As we increase irrigation, move to narrower rows and higher plant populations of corn or sorghum, the benefits from fertilizer are greater. There is tremendous potential for increased fertilizer use in South Dakota. Among the 12 North Central States in recent years, South Dakota has been the lowest in fertilizer use per crop acre. One reason claimed for the limited fertilizer use has been low and variable rainfall. However, fertilizer can cause more efficient use of the limited water supply. The following table summarizes Experiment Station research on fertilizer use related to water use efficiency for 18 nonfallow spring wheat plots during 1963-65:

Treatment N-P-K	Water used (inches)	Bu./inch of water used	Yield (bu./A)
30-9-0	11.7	1.57	18.1
0-0-0	11.3	1.17	13.0
Difference	.4	.40	5.1

LIVESTOCK FEEDING

South Dakota exports grain. At the same time we have excellent livestock feeding operations in certain locations. A summary of South Dakota farms in a recent year shows from $175 to $218 returned for $100 worth of feed fed to hogs. Similar returns are observed in cattle operations. Livestock feeding permits increased volume on limited acreage. It permits year-round use of labor and more complete use of management talent. Probably no other enterprise offers greater opportunity for economic growth in the state of South Dakota.

IMPROVING GRASSLANDS

The grasslands of South Dakota present a real challenge to those involved in education and research as well as to farm and ranch operators who own and manage them. The sale value of grassland has increased faster than has its productivity. Real estate taxes have increased faster than grassland productivity. To date, research has not provided the keys to sharply increase productivity to grass land as it has to cropland. Water conservation on range land, introduction of adapted species, rotation grazing, and certain other management practices have caused some increase in grassland productivity, but we haven't had a real "breakthrough." Perhaps a breakthrough will not come, but we will be directing continued research effort toward increasing grassland productivity. The answers will likely involve water, management, more new species, fertilizer, and a multiplicity of management practices. We will study the interactions of these factors and others.

KNOWLEDGE

The five items mentioned above to be effective for South Dakota agriculture will require not only *more knowledge* but the full *utilization of knowledge* now available.

As we move to more intensive agriculture, as each farm and ranch operator becomes responsible for higher capital investment, and each decision the operator makes becomes more critical financially, the need for knowledge on which to base decisions becomes paramount. Through the Agricultural Experiment Station, the Cooperative Extension Service, and the College of Agriculture and Biological Sciences at South Dakota State our job is to manufacture knowledge and to disseminate it to the citizens of South Dakota, including students pursuing degrees on campus.

It is heartening to know that more than 50% of the graduates of our College of Agriculture and Biological Sciences remain in South Dakota. Their increased knowledge makes them more productive on farms and ranches or in agricultural businesses. In contrast, 90% of the graduates of certain disciplines leave the state for employment.

The faculty I have joined at South Dakota State is ambitious and dedicated. They are well trained and they do good work. I am pleased to join with them and the citizens of South Dakota in working toward the benefit and improvement of South Dakota agriculture. — DUANE ACKER.

contents . . .

chemical control of wheat stem and leaf rust

By G. W. BUCHENAU, *associate professor,* and L. W. CARLSON, *assistant professor,* Plant Pathology Department

COVER. Microscopic view of a stem rust spore germinating (sprouting) in a film of water. The long object below is a dog hair for size comparison.

Control of rusts by the use of resistant varieties remains the most efficient method of control. However, new strains (races) of rust develop periodically which seriously reduce yields of wheat varieties resistant to the old strains. Chemical rust control is an emergency type control measure for use in those years when varietal resistance is inadequate.

NATURE OF THE RUSTS

South Dakota wheat crops are annually threatened by two different rusts; stem rust, sometimes called black stem rust, and leaf rust. Stem rust usually forms brick-red lesions on leaves and stems; leaf rust forms smaller, yellow-orange lesions on leaves.

Both rusts are caused by parasitic, microscopic plants called fungi (or molds). These fungi reproduce by means of tiny seedlike bodies known as spores (see cover). Each rust pustule produces thousands of these microscopic spores (the red "dust"), which are carried by air currents to other parts of the plant, to nearby plants, and may be carried for several hundred miles by wind. When a rust spore lands on a wheat plant, moisture (dew, rain) is necessary for germination and infection of the wheat plant. About 8 hours of favorable conditions enable the rust spore to germinate and to penetrate into the plant. Once inside a plant, the fungus uses the sap in the plant for food, grows, and reproduces a new crop of spores in about 7 days. This cycle of events may be repeated every 7 days as long as the wheat is green. As the wheat ripens, the fungus produces black spores (over-wintering stage), which are now of little significance to South Dakota farmers because of previous barberry eradication. Barberry, an alternate host, was an important source of early-season infection in many northern states before the intensive eradication program several years ago.

PRINCIPLES OF CHEMICAL CONTROL

1. Damage from rust is determined by the number of rust lesions (pustules) per plant and by the stage of growth of the crop in relation to crop maturity. The objectives of chemical rust control are to reduce the number of pustules per plant and to delay the development of such pustules as long as possible.

2. Rust fungicides presently available kill rust spores that land on the plant. They are not effective after the fungus has penetrated into the plant; therefore, the chemical must be present on the plant before infection occurs. Since each spore can produce only one pustule, most control programs do not attempt to kill the first spores of the season but delay spraying until perhaps one pustule per stem can be found. After this rust level is reached, pustule numbers will increase tenfold every 4 to 5 days under suitable conditions unless control measures are adopted.

3. Thorough and complete coverage of the foliage with the chemical is necessary. Several hundred rust spores per square inch are often deposited on plants in a single day during the peak rust season. Any part of the plant not covered with chemical will thus be severely rusted 7 to 10 days after one night of infection following a heavy dew or rain.

4. Leaf rust control may require slightly different spray timing than stem rust control because leaf rust nearly always develops earlier in the season.

PROMISING COMBINATIONS

Maneb fungicides have been used successfully against a wide range of plant diseases since 1950. Improved formulations of maneb-based fungicides are recent developments. (Manzate D—DuPont; Dithane M-22 Special, M-45, and S-31—Rohm & Haas.) In the late 1950's, nickel compounds were shown to be effective as rust fungicides; and patented combinations of nickel compounds and maneb have been widely tested for rust control with good results. Members of the Plant Pathology Department at South Dakota State University have been testing rust control chemicals for several years with the objective of finding a chemical that

Table 1. The Effect of Fungicides and Time of Application on Leaf Rust, Stem Rust Yield, and Test Weight of Nebred Winter Wheat at Presho, 1965

Treatment	No. Applications	Time of Applications and Stage of Plant Growth	Terminal Rust Severity* Leaf	Terminal Rust Severity* Stem	Test Wt. lbs./bu.	Yield bu./acre	Yield Increase† bu./acre
Maneb 1‡	6	Every 10 days starting 10 May	10.3	1.1	59.6	36.9	18.5
Maneb 1	4	Joint, Heading, Heading + 10 days, and Heading + 20 days	15.3	2.7	59.3	31.5	13.1
Zineb	6	Every 10 days starting 10 May	28.2	23.0	58.7	30.0	11.6
Maneb 1	2	Joint, Heading	19.9	17.7	59.0	29.7	11.3
Maneb + Nickel	2	Heading, Heading + 10 days	38.4	13.2	58.7	27.1	8.7
Maneb 1	2	Heading and Heading + 10 days	51.3	13.2	58.5	25.5	7.1
Zineb	2	Joint, Heading	37.0	23.0	57.6	24.4	6.0
Maneb 1	2	Heading + 10 days, Heading + 20 days	73.3	31.5	55.8	20.7	2.3
Check (No chemical)	0	———	70.3	51.8	55.2	18.4	0

*Indicates approximate percentage of leaf or stem surface covered with rust.
†Indicates increase in yield over check plot. LSD at 5% level = 2.9 bu./acre.
‡Maneb 1 designates maneb fungicide containing zinc.

will effectively control stem and leaf rust with no more than one or two applications during a season.

Table 2. Effect of Time and Number of Applications on Nebred Winter Wheat Yields and Net Returns When Using Maneb 1 for Rust Control at Presho, 1965

No. Applications and Growth Stages When Applied	Rust Control* Leaf	Rust Control* Stem	Yield Increase bu./acre	Net Return $/acre
	%	%		
6 Applications				
Every 10 days starting 10 May	85	98	18.5	$4.88
4 Applications				
Joint, Heading, Heading + 10 days, and Heading + 20 days	78	95	13.1	$4.29
2 Applications				
Joint, heading	72	66	11.3	$8.58
Heading, Heading + 10 days	25	75	7.1	$2.89
Heading + 10 days, Heading + 20 days	0	39	2.3	—$3.59

*100% equals complete control.

FIELD EXPERIMENTS AT PRESHO

Experiments at the South Central Research Farm near Presho in 1965 were designed primarily to study the most effective time of application in relation to rust infection on the crop. Chemicals were applied with a ground applicator calibrated to deliver 100 gal./acre at 150 pounds per square inch of pressure. Drop nozzles were utilized to ensure thorough coverage of stems and lower leaves. Maneb 1 (a designation for a maneb fungicide containing zinc) was used as the standard rust protectant and was applied in several different schedules (tables 1, 2). All treatments were applied at 10-day intervals.

Table 2 summarizes the results from plots sprayed with one chemical at different dates. Season long rust protection (6 sprays) doubled wheat yield. Four applications with the first application made at the jointing stage resulted in excellent stem rust and good leaf rust control. This schedule did not control leaf rust as well as the full season schedule, and yield data reflect this response.

The best timing for a 2-spray schedule at Presho in 1965 was at jointing and 10 days later (heading stage). This schedule resulted in reasonably good control of both rusts. Two-spray schedules starting at heading provided better control of stem rust but little leaf rust control. Spray schedules starting 10 days after heading were applied too late for appreciable control of either rust in 1965.

Zineb was definitely inferior to Maneb 1 as a rust control chemical in these tests. Maneb + Nickel provided somewhat better rust control than Maneb 1 but was slightly less profitable because of its greater dosage requirement.

FIELD EXPERIMENTS AT HAYES

Experiments designed to compare rust control chemicals were also conducted on the David Muirhead land near Hayes. The data (table 3) indicated that zineb was inferior to two other chemicals. Little difference was observed between Maneb 1 and Maneb + Nickel in the control of rust, but the former has considerable advantage from a cost standpoint.

The best timing for two applications was not clearly demonstrated in the Hayes test. Again, leaf rust control was best accomplished by sprays at joint and heading, while stem rust was more effectively controlled when sprayed at heading and 10 days later. A summary of the effectiveness of individual spray dates is presented in table 4. Against leaf rust, the two early sprays were effective at both locations except that early spraying was more effective at Presho than at Hayes. This was due to the fact that rust development occurred 4 to 6 days earlier at Presho than at Hayes (figure 2). No leaf rust control benefits were obtained at any location when plots were sprayed

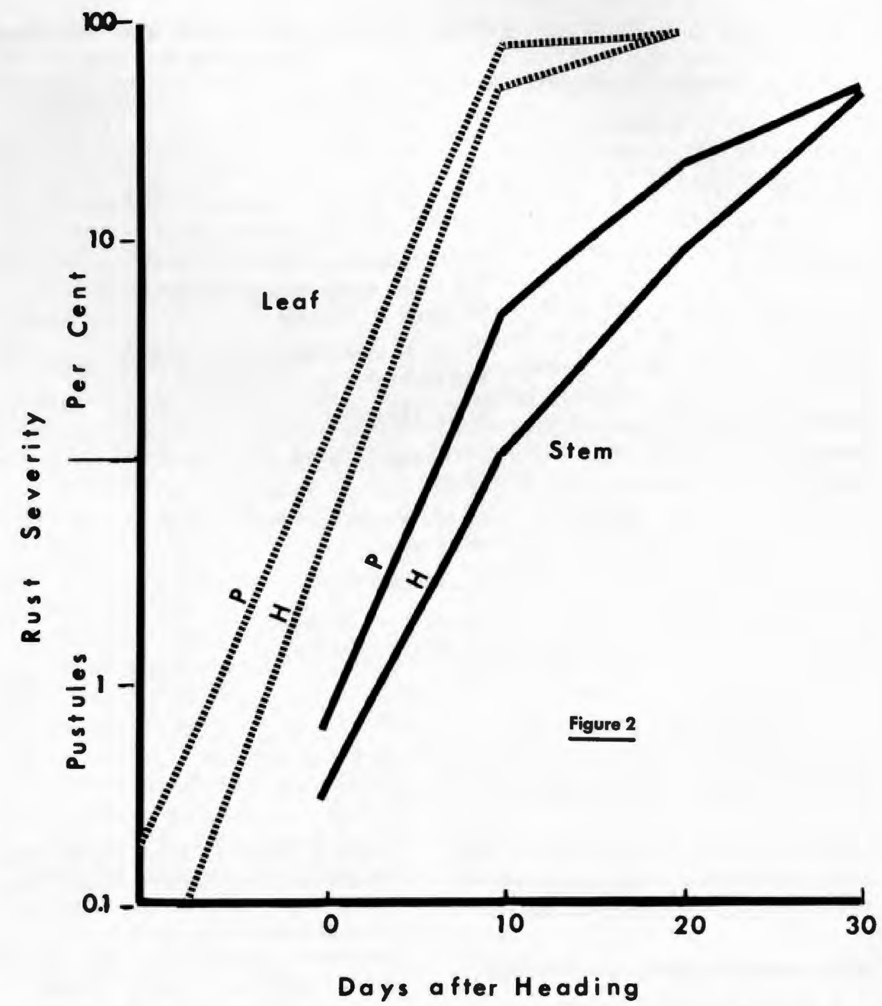


Figure 2

Development of leaf rust and stem rust epidemic at Presho (P) and Hayes (H) in 1965.

Table 3. Effect of Maneb 1, Maneb + Nickel, and Zineb on Rust Control, Yield, and Return from Spraying Omaha Winter Wheat at Hayes in 1965

No. Appli-cations	Growth Stages When Applied	Chemical	Rust Control (C_1)* Stem Rust	Leaf Rust	Yield Increase† bu./acre	Net Return from Sprays $/acre
			%	%		
6	Every 10 days starting 10 May	Maneb 1	99	87	17.9 (49.1)	4.09
		Maneb + Nickel	98	93	17.8	—4.56
		Zineb	63	75	11.1	—2.10
3	Joint, Heading and Heading + 10 days	Maneb 1	94	88	14.2	9.15
		Maneb + Nickel	98	94	13.7	4.22
		Zineb	42	79	8.2	2.65
2	Heading and Heading + 10 days	Maneb 1	96	49	12.2	9.80
		Maneb + Nickel	77	58	9.1	2.78
		Zineb	31	27	7.4	4.30
2	Joint and Heading	Maneb 1	31	88	10.6	7.60
		Maneb + Nickel	25	87	12.1	6.81
		Zineb	15	73	5.3	1.45
None (Check)			0	0	0 (31.2)	0

*Rust control (C_1): 100% = complete control.
†Yield increase = increase over check. Figures in parentheses are actual yields.

Table 4. Rust Control Obtained with Maneb 1 Applied at Each of Three Plant Growth Stages in 1965

Time of Application	Control* Leaf Rust Presho	Leaf Rust Hayes	Stem Rust Presho	Stem Rust Hayes
	%	%	%	%
Jointing	53	39	20	0
Heading	25	49	46	31
Heading + 10 days	0	0	29	63

*100% equals complete rust control.

10 days after heading or later.

Late sprays (heading and 10 days later) were effective for stem rust control at both locations, and early sprays at the jointing stage provided no stem rust control at Hayes.

Additional experiments will be needed to clarify which fungicide is most effective, and more specific information is needed regarding the effect of stand density on spray coverage and yield. Also, insufficient data is available regarding the effectiveness of airplane application of rust control chemicals. The major problem is thorough coverage of all surfaces of the wheat plant. Limited tests, however, indicate that aerial application can give good results.

The more promising chemicals (Maneb 1, Maneb + Nickel) have not to date received approval for use by the United States Food and Drug Administration. However, these materials or similar compounds are under consideration for approval and may be acted upon by June 1966.

In general, sprays applied more than 10 days after heading have not been effective. Normally, control of rust by spraying with these fungicides cannot be easily seen until about 2 weeks following an application. This lag occurs because infections that occurred preceding the spray become visible in 7 to 10 days.

Studies are being directed at information that will make it possible to develop a rust forecasting program similar to frost forecast warnings for orange growers, so growers will know in advance when chemical rust control is advisable. □

COW-CALF OPERATORS

adjustments in production

By John E. Trierweiler, *assistant*,
and Donald B. Erickson,
assistant professor,
Department of Economics.

How do farmers and ranchers change their operations when the price of beef calves, or the cost of producing calves, increases or decreases?

What is the effect of technological innovations on the cow-calf industry?

These are some of the questions asked by farmers, ranchers, outlook workers and policy makers in the agricultural industry. Neither the questions nor the answers are new. The only variation is in the degree of adjustment to the situation from one area of production to the next, from one period in time to the next.

In seeking solutions to these questions of response or adjustment in production, the study reported here was undertaken. The entire United States was analyzed first and then South Dakota. The period used was 1950 to 1963.

UNIQUE INDUSTRY

The production of beef cattle is a unique industry in agriculture and business. From the time the cow-calf operator makes the decision to increase production until the new heifers start producing calves, there is a time lag of about 3 years. The major reason for the length of time to alter production is the physiological capabilities of the cattle. Decreases in production can occur more rapidly than an increase because of the ease of liquidation. The planning period for beef calves is 3 months, plus 9 months for the gestation period, and 18 months to 2 years or more to grow heifers out before they in turn can start producing calves. During the 3-year period the cow-calf operator has several alternatives. The calves can be slaughtered as vealers (this is seldom done except for dairy calves), held over as replacements in the cow herd or held over as yearlings to be fed.

A number of equations, called models, were experimented with in order to estimate the variation in the beef calf production and at the same time fulfill the following restrictions. The restrictions were that the models must contain at least one variable that reflected the price of the product, one variable for cost of production, and one biological factor. The biological factor was necessary because of the nature of the product and the length of time necessary for the expansion of the industry's output.

The average price for good and choice stocker-feeder calves at Kansas City for the months of September, October and November was chosen to reflect the price of the product. Because of the length of time needed for producers to react to changes in price, this variable was lagged 3 years. The Kansas City market was considered to be the price leader in the stocker-feeder price division. The fall months were chosen because they represent the heaviest marketings of feeder calves. The stocker-feeder price was then deflated by the index of wholesale prices.

Since calves are usually weaned and sold in September or October, these months were chosen as indicators of pasture or range conditions. Decisions to hold cows over for the next production period or to reduce the size of the herd were made at this time. The amount of range feed available was an important factor in the decision of the cow-calf operation, especially with the approach of winter.

The response of the farmers and ranchers was measured to compare the relationship of changes in product price, cost of production and technological innovation.

The results showed that for a 1% change in the stocker-feeder price, calf production changed .12 of 1% 3 years after the price change.[1] For example, an increase in feeder calf price from $24.00 to $25.00 per hundred would bring about a 3% increase in the number of beef calves produced. The response indicated that cow-calf operators were slow to adjust production plans as a result of a change in price. The slow response results from two inherent characteristics of the cow-calf industry: first, the length of time necessary for the expansion of the industry's capacity, and, second, the length of time from the beginning of gestation to the marketing of the beef calves as feeders. During the planning period, producers must estimate the price of feeder calves 1½ years in advance.

A 1% change in pasture conditions indicated an adjustment in production of only .15 of 1%. First, it should be noted that pasture conditions were taken as a national unweighted average, and did not consider movements of cattle to other regions where drought may not have been prevalent at the time. Second, cow-calf operators did not have to speculate about future pasture conditions so far in advance as feeder calf price. If pasture conditions were poor, operators made the choice of reducing the size of their herds, or purchasing feed to supplement the pasture. If pasture conditions were relatively good, herds could be increased by purchasing replacements from regions with relatively poor pasture conditions.

A .01% adjustment was made by cow - calf operators as a result of a 1% change in time. Time, representing technology in the model, indicated that cow-calf operators were slow in the adoption of technological innovations. However, technological innovation attributable to breeding practices, pasture management and pasture improvements was not measured.

The biological variable, cows on hand lagged 1 year, indicated that for a 1% change in the number of beef cows, cow-calf operators adjusted production of beef calves .85%. This appears to reflect the calving rate for beef cows held over for breeding. Cow-calf operators, therefore, produce beef calves as close to the capacity as the number of cows on hand permit.

The four variables, price, pasture condition, technology, and cows on hand, explained 97.6% of the variation from year to year in the number of beef calves produced.

Livestock production in South Dakota is generally divided into cow-calf operations in the western part and feed-lot operations in the eastern. Western South Dakota is mainly non-feeding grassland areas, while the eastern section is characterized by intensified feed grain production.

While the above models state the national production response, results from South Dakota tend to vary somewhat. During the same period, South Dakota farmers and ranchers adjusted production .10% for a 1% change in the stocker-feeder price, compared to a .06% adjustment in output in response to a 1% change in range conditions. This relationship indicated that cow-calf operators in South Dakota responded slightly more to changes in price than changes in cost of production. Technological change in South Dakota at .09% was greater than the national average (.01%), indicating that cow-calf operators in South Dakota generally adopted technological innovations faster than the cow-calf industry as a whole (table 1).

Table 1. Comparisons in rate of adjustments in production by the cow-calf industry in the United States and South Dakota.

	United States	South Dakota
Price	.12	.10
Range Condition	.15	.06
Technology	.01	.09
Cows on Hand	.85	.87

In the cow-calf industry major supply responses are not instantaneous. Because of physiological characteristics and the reluctance of cow-calf operators to make major changes in the size of their herds, supply responses may take 3 years or more before actual increases in the number of beef calves born. A decision by the operator to decrease the number of cattle can be implemented faster because of the quicker process of liquidation by slaughter.

Cow-calf operators were reluctant to make adjustments in output in response to changes in product price, cost of production or technology. Two major reasons for the slow response appear to have been: First, the length of time from the beginning of production to marketing of the calves as feeders, and, second, the length of time necessary for the expansion of the industry's capacity. During these periods producers must speculate as to what the product price, cost of production, and salvage value of cull cows will be 1½ to 4 years in advance.

Cow-calf operators, therefore, produce as close to capacity as the number of cows on hand and pasture or range conditions permit. A slightly greater amount of emphasis is placed upon changes in pasture or range conditions than changes in stocker-feeder price. Cow-calf producers are more likely to increase the size of the breeding herd by saving heifers when the stocker-feeder price increases, even to the point of overstocking the ranges. However, if the stocker-feeder price decreases, producers are not likely to adjust production by decreasing the size of the breeding herd, assuming that range conditions remain relatively stable.

Cows on hand and pasture or range conditions can be considered as a reflection of production costs. Producers have a better idea of their costs (i.e., value of breeding stock, range conditions, feed costs), but must speculate about future prices that will be received for their product years in advance. Thus, current prices are used as a guide for what future prices are expected to be. Based on these estimates, the production of calves is based more on the changing costs and range conditions than on expected prices. The response to changes of the product price are very low thus making the cow-calf industry a cost oriented operation. □

[1] This analysis assumes that other factors of production remain unchanged. In this case pasture conditions and technology are held constant.

High Quality Paper . . .

A FLAX STRAW BY-PRODUCT

By WINSTON K. ULLMAN,
associate professor,
Economics Department

A dollar or two more an acre from a flaxseed crop by-product would represent a sizable chunk of money for northeastern South Dakota farmers who last year harvested an estimated 563,000 acres of flax.

The by-product is flax straw.

From it is made high-quality paper, sometimes known as Bible paper. This is used in producing currency, cigarettes, fine writing paper, and books where strong, opaque paper with a minimum of bulk is needed. Increasing demand for paper of this type opens possible expanding markets. Nearly every American uses flax straw paper of some form every day.

But it is a long and somewhat complicated process from the flax straw in the field to the extra money in the pocket of the farmer.

South Dakota is the nation's second largest producer of flaxseed with 1965 – an exceedingly good flax year – producing a total estimated farm value upwards of $22 million. Newer varieties and a better understanding of cultural practices have enabled flax production to spread west into a wider area of the state.

The paper industry has traditionally purchased its flax straw from independent straw assemblers or franchised dealers. This has enabled the industry to purchase its straw requirements with a minimum procurement effort. Few South Dakota farmers know of the flax straw quality requirements of the paper industry. Because of this, straw assemblers sometimes have been capitalizing on the "flax straw nuisance" or "negative value" to farmers. Such procurement practices have maintained a lack of understanding and in some cases mistrust between farm producers and the flax straw paper industry. Rejected straw in the field or failure of assemblers to remove straw from fields contracted has encouraged farmers to burn their straw or purchase straw choppers. This has tended to further reduce the available supply and has done nothing to encourage the improvement of flax straw quality at the farm.

A "mobile flax straw decorticator" in action following flaxseed harvest near Brookings in 1965. This machine, claimed to be the only one of its kind in the world, processes flax straw directly from windrows in the field into "tow" for ultimate shipment to a paper factory (in this case in New Jersey). Field men supervising operation of the machine said that in removing the tow, 60% of the straw is returned to the ground as fertilizer-humus. At stationary processing sites this excess is sometimes sold for turkey litter.

A price quoted by field men was $1.10 a bale or $4 to $5 a ton for straw. The machine covers 40 to 120 acres daily (and can work at night also, conditions permitting) depending on the kind of straw and moisture conditions. Each bale weighs 200-250 pounds.

Tow yield is affected by weathering as well as flax straw tonnage, according to those familiar with the process. The tow generally yields a higher percentage on fields that have had sufficient rain or dew to loosen the natural "glue" binding of the tow fiber. Without this weathering the straw tends to be brittle and a larger percentage of tow fiber disintegrates in the decorticator. The portable machine is equipped to add some water to the straw as it enters the machine to partially compensate for this.

LARGE MILLS IN EAST

The paper industry and South Dakota flax producers have much to gain by a better understanding of each other's production problems and requirements. These problems mostly center around straw purity and bulk as it affects storage and transportation to paper mills of flax straw or "tow," the decorticated material.

Paper mills processing flax straw tow are in the East near population centers and where large quantities of water are available. Since the major market for the high quality paper is near population centers, mills will remain 1,500 miles or more from major flax straw production areas. The industry becomes more efficient with every development that reduces "bulk" and/or "unnecessary or inefficient handling" (while maintaining or improving the tow yield) between the flax field and the paper mill. Paper mills operate continuously for 30 days or more at a time, thus a uniform and steady supply of tow is needed. In contrast the flax straw is harvested over about a 30-day period once a year. This contrast in production requirements between farm flax producers and the flax straw paper industry can best be resolved by working together.

BULK REDUCTION

The industry has established regional tow centers in North Dakota, South Dakota and Minnesota as well as a portable tow mill that can operate in the flax fields. These stationary or portable mills remove most of the separable inert foreign material and bale the remaining tow in large, very dense, wire-tied bales weighing between 200 and 250 pounds. Like the paper mill, these large and expensive machines have insufficient capacity to process a year's supply within the 30-day flax harvest period. They must be operated over a much longer season for economic efficiency. They reduce the bulk and weight sufficiently to enable economical freight shipment of flax tow to the East Coast.

Where flax straw is yielding 40% tow, one tow bale of 240 pounds represents 600 pounds of flax straw. This "refinement" of raw flax straw in the field or at flax straw assembly yards reduces bulk sufficiently so that freight cars can be loaded to near capacity, thus facilitating economical shipment.

LOCAL STRAW ASSEMBLY, STORAGE

The straw harvest season is short because flax straw must be removed as soon as possible before plowing and readying the field for the next crop. The volume of straw can only be handled in this short period by utilizing existing farm and commercial balers and local on-farm transportation. Here again bulk and "useful weight" largely determine whether straw may be economically used in paper. As with hay, transportation costs are lower with dense, pure, clean straw bales. Excessive foreign material increases flax straw handling, freight and processing costs beyond its value for paper production.

Stacking baled flax straw either on the farm or at a community flax straw yard represents the alternative flax straw market. Baling, stacking, and storing flax straw on the farm represents added service and value to the paper mill. Farmers who are willing and able to perform these services may realize between $14 and $16 per ton for their straw. There are not enough field operating decorticators to process all the flax straw needed. Then too, wet field conditions can restrict their operation more than farm balers and flat bed transport.

Community, dealer, or farm storage areas have facilitated the use of small farm trucks and flatbeds. This has enabled fields to be cleared faster and also reduces the risk of fire loss by dispersing the stored straw over a wide area. Some straw must be stored 12 months or longer due to the need for necessary reserves as well as the year 'round processing demand. This function can usually be performed locally at least as cheaply as at processing centers. These storage practices enable fuller utilization of larger specialized straw transports and experienced loading and handling crews. This also provides added revenue for the rural producing area.

Here are some standards which farmers may use as guides in determining how marketing a flax seed crop by-product may fit into their farm operation.

BALES

Improper baling can cause straw rejection.

Bales may be wired or twine tied. Twine tied bales must be treated for rot, mildew and against insects and rodents. Black twine is unacceptable.

Bale must weigh 42 pounds or more for economical transportation. Where bale length exceeds 38 inches a heavier bale will be required.

FARM STRAW STORAGE

Stack must be accessible from an all weather road.

Stack must be located on high ground.

Each stack must be erected according to an acceptable plan and contain from 300 to 1,000 bales.

Bales must be packed tightly together on the outside.

Sides of the stack must be straight.

Stacks must be at least 200 feet

Loading "tow" baled in the field.

from farm buildings, railroad tracks, power lines.

Stacks must not be accessible to livestock — fenced stacks must have sufficient clearance for trucks to load within the fenced area.

STRAW STANDARDS

Foreign material in straw cannot exceed 10%. Larger amounts increase baling, transportation, and preliminary processing cost per bale of flax tow beyond acceptable limits.

Moisture content must not exceed 15%. Excessive moisture adds weight and contributes to deterioration of straw and bale ties during storage. This can contribute to stack failure and a resulting straw deterioration loss.

The straw must be 8 inches long and of gray or brown color. Green straw is not acceptable.

Straw must be free of cockleburrs. Cockleburrs cannot be separated from flax straw and will not break up in the paper making process. The straw then becomes worthless for paper production.

These standards are all parallel and compatible with flaxseed production. Furthermore, when they are understood by farmers, total net flax returns may be increased $1 to $1.50 per acre. □

Flax straw "tow."

wear and cleaning of fabric to fabric laminates

Before and after wear and cleaning. Front — Swatch of new fabric. Center — Dry cleaned five times. Back — Dry cleaned five times and laundered three times.

By LILLIAN O. LUND,
professor of textiles research;
CORA R. SIVERS,
assistant professor of home management;
and COILA M. JANECEK,
instructor in textiles research.

You hear more and more about fabric to fabric laminates as their use and availability steadily increase.

But, how do they wear? How do they clean? How do they stand up?

Textiles research conducted by the Agricultural Experiment Station Home Economics Department provides some of the answers through an investigation designed to match "home conditions" as closely as possible.

These laminates may consist of a lace, woven or knitted fabric bonded to a lining by means of an adhesive so that the two fabrics become one. A commonly used lining is *tricot*, (a word from French meaning "knit" and pronounced "TREE-co"). Laminates, first used in sportswear in 1959 and now appearing in many types of wearing apparel, are claimed to provide a number of advantages. These advantages are good shape retention, resistance to wrinkling, additional strength at stress points, comfort next to the body, and economy through elimination of a separate lining.

FABRICS INVESTIGATED

For this investigation two types of fabrics were purchased — a white cotton lace and a yellow wool flannel, both bonded to acetate tricot. The lace laminate was made into blouses and the flannel into skirts. Since labels specifically stated that the fabrics should be dry cleaned only, this was the process used. Each person taking part wore the blouses and skirts 3 days after which the garments were dry cleaned. This procedure was repeated five times.

The fabric to fabric laminates did show ability to resist wrinkles although wrinkle recovery diminished as the dry cleaning and wearing progressed. Laminated and plain flannels, measured for wrinkle resistance showed the same tendency in an earlier study (reported by Miss Lund and Mrs. Janecek in "Double-faced Fabrics,"

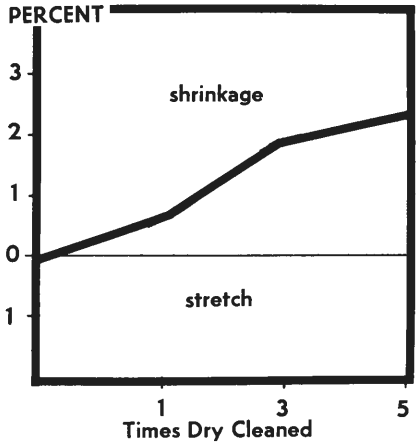


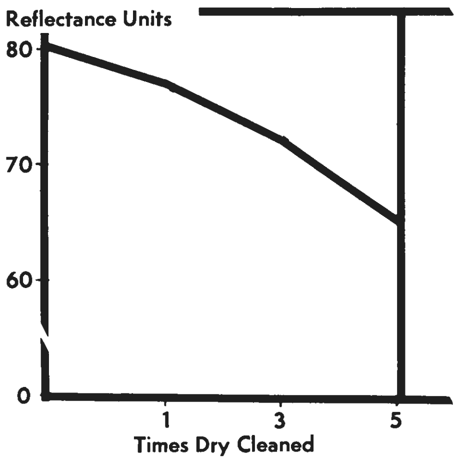
Chart 1. Percent dimensional change on skirts, warp direction (lengthwise), after dry cleaning.

Journal of Home Economics, 57(5): 1965).

To observe the ability of the laminated flannel to retain pleats, the skirts were constructed with a back pleat. This pleat, put in with a regular steam iron, kept a sharp crease throughout the wearing periods.

Some of the earlier fabrics, those bonded to foam as well as to acetate, tended to debond or separate in spots. Because of this weakness the bonding was carefully observed throughout this study. After five periods of wear and dry cleaning the lace had not debonded. However, the skirts did debond in several places but this was not visible on the right side.

Chart 3A. Whiteness reflectance of one blouse after repeated dry cleanings.



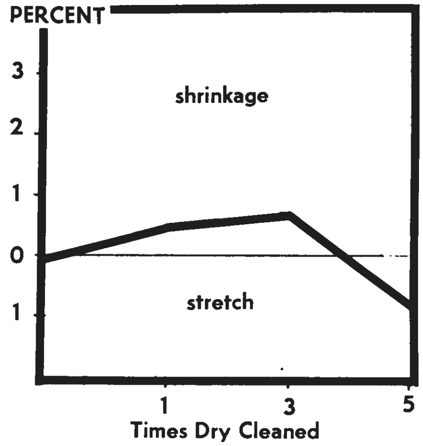


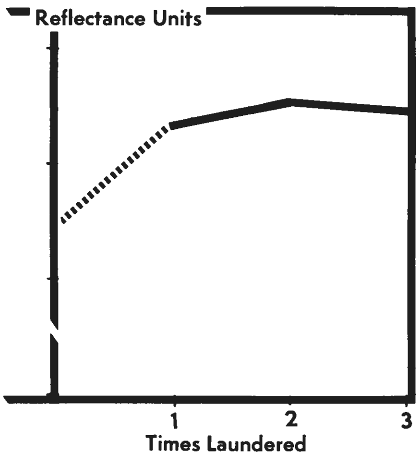
Chart 2. Percent dimensional change on skirts, filling direction (crosswise), after dry cleaning.

SHRINKAGE FROM DRY CLEANING

The garments were sent to two dry cleaners, each using a different solvent. No appreciable difference was observed between the two cleaning processes. After first, third, and fifth cleanings, skirt measurements showed greater shrinkage in the warp, or lengthwise, direction than in the filling, or crosswise, direction (charts 1 and 2). The maximum lengthwise shrinkage in the skirts was less than 2.5% which did not appreciably alter the fit or appearance.

The cotton lace blouses shrank nearly 4% in the lengthwise direction. Since this was an overblouse such shrinkage was not serious.

Chart 3B. Whiteness reflectance of same blouse as in Chart 3A after three launderings.



COLOR RETENTION

As dry cleaning continued, the yellow skirts lost some clarity of color. However, they were still acceptable for wearing.

Cotton lace did not respond well to dry cleaning when appearance was considered. As the process continued, the lace changed from white to deep cream in color. It also lost crispness and body with each cleaning.

Due to loss of whiteness (chart 3a), the lace blouses became unacceptable for wearing. To determine if laundering could restore whiteness, one blouse was hand laundered using a synthetic detergent and an oxygen bleach in softened water. Whiteness was measured after each of three consecutive launderings. Whiteness was partially restored with the first laundering, and then remained at about the same level thereafter. Chart 3b illustrates that washing restored much of the whiteness — not "as good as new" but considerably whiter than after the final dry cleaning. A second blouse was treated similarly with the same results. The blouses looked white on visual inspection and were acceptable.

SHRINKAGE FROM LAUNDERING

Although laundering improved whiteness of the blouses markedly, it caused variable amounts of shrinkage. In some cases lengthwise shrinkage measured up to 7% in one blouse and only 3% to 4% in another. Although not investigated thoroughly in this study, it should be pointed out that perhaps one reason the fabric was labeled "dry clean only" was the possibility of excessive shrinkage if laundered.

Swatches with 18-inch shrink markings were dry cleaned along with the garments. The garments showed less shrinkage than the swatches. Apparently wearing caused the garments to stretch and thus overcome some of the shrinkage which occurred during dry cleaning.

This somewhat limited study does not lend itself to general conclusions but it may suggest ideas in the use and maintenance of such fabrics. □

SD 230 A NEW CORN HYBRID

By D. Boyd Shank, *professor,* and Durwood W. Beatty, *assistant professor,* Agronomy, and C. M. Nagel, *professor* and *head,* Plant Pathology Department

(Available to farmers in 1968).

Seed for a new corn hybrid just developed by the Agricultural Experiment Station will be released to commercial producers for certified seed production in 1967. Commercial double cross hybrid seed should be available to farmers for planting in 1968.

The new hybrid – designated South Dakota 230 – was released through the South Dakota State University Foundation Seed Stock Division.

SD 230 is adapted to the area north of Highway US 212 corresponding to that of SD 240, another Agricultural Experiment Station release which became available to farmers in 1962. However, SD 230 has a higher yield potential than SD 220 and SD 240 and is intermediate between the two in maturity as indicated by moisture percentage at harvest (see table).

SD 230 grows 6½ to 7 feet tall. The ears appear thick in the husk and are borne close to the stalk on a short shank. The plants have a straight stalk, stay green to the base, and are free from blemishes late in the season.

The pedigree of SD 230 is (SD26 × B8) (SD20 × SDP1). The single cross made up of South Dakota inbred SD 26 and Iowa inbred B8 is the female parent just as it is in the double cross hybrids SD 220 and SD 240. This single cross makes an excellent seed parent because it produces a high percentage of good quality medium flat kernels. The other single cross is composed of SD P1, an inbred developed in the root rot resistance program of the SDSU Plant Pathology Department, and SD 20, a new inbred line being used for the first time in a released hybrid.

The new inbred SD 20 was developed from a cross made in 1950 between two inbreds, SD 5 and Ohio 56A. It contributes good yielding ability and is presently being evaluated for use in other hybrid combinations. □

Performance of SD 230 and Several Competitive Hybrids, Codington County*

	1962		1963		1964		1965		1962-65 Av.	
Hybrid	Yield bu/A	Moisture percent	Yield bu/A	Moisture percent	Yield bu/A	Moisture percent	Yield bu/A	Moisture percent	Yield bu/A	Moisture percent
SD 220	47.0	36.8	71.0	27.4	42.4	21.0	44.2	31.3	51.2	29.1
SD 240	46.4	44.2	86.6	33.4	43.4	26.9	40.5	39.8	54.2	36.0
SD 230†	54.1	40.0	90.0	30.9	43.9	25.4	48.4	34.1	59.2	32.6
Pioneer 388	48.2	42.0	76.0	27.8	32.4	26.0	45.9	36.4	50.6	28.5
Sokota 255	45.1	47.4	88.0	35.8	38.2	22.9	46.4	28.5	53.6	32.4

*Data from Corn Performance Trial circulars 1962-1965.
†Listed as Experimental 39 in Corn Performance Trials.

THE RUMINAL ENVIRONMENT . . .

Where a Population Explosi

By L. D. Kamstra, *professor,*
Animal Science Department

(Acknowledgment is given to a research associate, L. B. Embry, and to graduate students in the Department of Animal Science cooperating in this project).

An accidental gunshot wound in the stomach of a Canadian voyageur, Alexis St. Martin, on June 6, 1822, created an opportunity for the first detailed study of gastric digestion. The open fistula allowed a Dr. William Beaumont to complete his now famous experiments with stomach secretions and their digestion of various foods consumed by humans. These initial investigations provided a sound basis for understanding non-ruminant digestion and, additionally, similar processes in the true stomach (abomasum) of ruminants (cud-chewing animals such as cattle, sheep, antelope, deer and others).

But much less is known about the three digestive compartments (rumen, reticulum and omasum) which precede the true stomach in the digestive tract of ruminants.

The ruminant swallows partly chewed herbaceous feed which goes either to the farthest depths of the rumen by movements of the muscular pillars or to the adjacent organ, the reticulum. Later, while at rest, the animal regurgitates this feed in small masses for a more thorough mastication (cud chewing) and an additional mixing with saliva. Then it is again swallowed and pre-digested by microbiological action during which some of the materials are directly available for use by the animal. These include volatile fatty acids (mainly acetic, propionic and butyric acids) and B complex vitamins. Also, protein material is synthesized and proceeds with the residues from the fiber for further digestion in the abomasum where it is acted upon by gastric juices. This entire process is quite unique in that it enables the ruminant to convert high roughage rations (grass, hay, silage) into meat, milk, hide, hair, blood and bone.

INSIDE LIVING ANIMAL

Dr. Beaumont nearly 150 years ago secured his human digestion information because of an accident. Now, veterinarians through careful surgery place special rubber, wooden, metal or plastice devices or "doors" in cattle and sheep so that studies can be made of the digestive process going on inside the living animal. These are referred to as "ru-

THE "INSIDE" STORY

What's it like inside a living cow's digestive "fermentation vat?" What goes on? Why do ration changes, for instance, cause animals to go "off feed?"

South Dakota State University animal scientists are attempting to learn more about the digestive process of ruminants (cattle and sheep, in this case). To do this, the Agricultural Experiment Station scientists, assisted by veterinarians, install a special "door" in the side of an animal. Through such an opening, or fistula, researchers obtain samples of liquids and solids which give clues to what is going on inside the living animal.

L. D. Kamstra in the accompanying article reports on a few preliminary findings in this research. Briefly, some findings indicate that:

The inter-relationships of the microorganisms (bacteria, protozoa) living in the digestive compartments are so complex that only after more knowledge is gained can many of the practical applications of the research be spelled out.

The microscopic inhabitants of the rumen ("fermentation vat") are quite sensitive and differ in type for digestion of high and low roughage rations, for instance. Thus if animals go off feed during sudden ration switches it may be caused by a failure to allow the rumen organisms sufficient time to adjust to this new diet. While "feed the bacteria to feed the animal" appears to be an appropriate description of the relationship between the ruminant and the friendly inhabitants of its digestive system, scientists say this is an over-simplification.

Certain types of microorganisms may have to become predominant (that is, have a "population explosion") or change their cooperative activities to be able to assimulate all ration components and by-products which result. The lag in microbiological activity during the period of adjustment is reflected in the animal's ability to utilize feed.

Researchers think they may soon discover why an animal loses ability to digest fiber when fed a high concentrate diet.

Generally, cows and sheep on similar feeds have similar rumen environments and microbiological populations.

Animals appear to thrive even with a door in their side. They seem to approve of being "tickled" internally during sampling procedures and respond by going through movements of rumination. Some animals have been on these experiments for as long as 8 years. Many become fat and outgrow their pens during a lengthy experimental period.

Wires, nails, plastic bags, or hair accumulations (hairballs) eaten by ruminants can be removed through the doors since the reticulum (called the "hardware pouch") is within easy reach from the rumen. The knowledge that heavy materials such as hardware settle to the bottom of the reticulum might be useful since functional hardware could be introduced orally into the reticulum in a form to furnish trace minerals, counteractants to toxic materials consumed by the animal, pest or disease control, or to assist in special nutritional problems.

(Microbiological) Is Needed

men fistulated" or "cannulated" animals.

Right off, the question arises of creating abnormal conditions in the animal by using these openings. Does an animal with a door in its side go about a regular daily living pattern much the same as a normal animal? Little difference has been found between the cannulated and normal animals — and the door itself apparently does not particularly bother the animal.

Rumen microflora are anaerobic, that is they live in the absence of free oxygen or air. Thus, would air entering the rumen when feed samples are removed produce changes in type, number, or level of activity of certain desirable organisms? To measure how much of a factor this might be, 10 cannulated and 10 uncannulated wether lambs were compared for growth and digestive ability. Again, little difference was found (tables 1 and 2). If anything, a slight advantage was suggested for cannulated lambs but the difference was not significant.

This opened the way for more detailed research on what goes on in a healthy, live ruminant's digestive "fermentation vat." For certain parts of this research, an even closer check was necessary. This was accomplished by using laboratory apparatus to duplicate certain ruminant digestion processes. Continued effort produced a laboratory set-up which, artificially, was the equivalent of 70 cows. By using rumen fluids from the animals a closely controlled research vigil could be kept in the laboratory on what was happening. If something suddenly changed or went wrong it was readily apparent. Researchers were even able to cure artificial "sour stomach."

DIGESTIVE POTENTIALS COMPARED

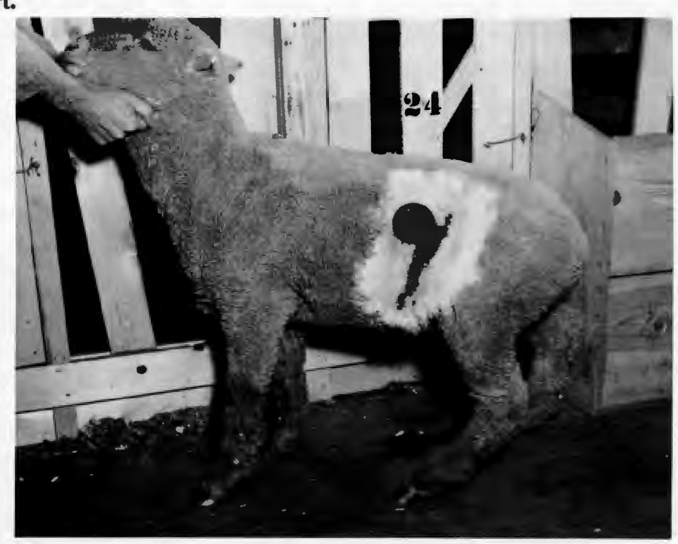
Cannulated cattle and sheep from which rumen fluid was taken for laboratory digestion trials were maintained on a 70% roughage ration of alfalfa hay, rolled shelled corn and soybean oil meal. Laboratory fiber or cellulose digestion values were determined (by the artificial rumen) using sheep and cow fluid on corresponding samples of 22 different rations having various fiber levels.

A high correlation or similarity was found between sheep and cow rumen fluid in the ability to digest cellulose within these rations as fed to the laboratory cow. Whether this laboratory fermentation was allowed to proceed for 24 or 48 hours did not appear to effect the relationship of cow and sheep rumen fluid.

CONDITIONS CONSTANTLY CHANGE

When collecting fluid at different times for various experiments, it was noted that rumen conditions could not be expected to remain constant from day to day or from hour to hour—even when animals were held to constant rations. Cannulated twin steers and four wether lambs were used to look into how and when ruminal changes occur. The steers and two lambs were kept on a high roughage ration for a 28-week test period (April to October). The other two lambs were switched from high roughage to low roughage on the 11th week and remained on this ration for 14 weeks before

Animals with the cannula installed. The operation is performed under local anesthesia by veterinarians. The cannulated animals thrive and apparently do not suffer discomfort.



A tube from a suction pump is inserted in the cannula to remove samples of rumen contents.

being returned to the original ration. Measurements of acidity (pH) and temperature were made periodically directly through the rumen cannula of each experimental animal. The acidity of the rumen was lowest and temperature highest about 3 hours after feeding (noon reading) with a gradual rise in pH and lowering of temperature before the evening feeding. The reading taken before the morning feeding showed the highest pH (less acidic) and lowest temperature — probably a reflection of the greater length of time between the evening and morning feeding. Figure 1 shows the averages of the morning, noon and evening readings by weeks for a sheep during a 28-week period.

Activity, as measured by the ability of the rumen fluid to digest cellulose over a 22-hour period, was highest at periods of lowest acidity or pH. The data for the entire period suggests not only daily changes within the rumen but perhaps seasonal fluctuations. The only noticeable seasonal effect in this experiment was a slightly higher midsummer ruminal temperature. Australian investigators have found that bacterial concentrations and pH were lowest in May, highest in October.

The ruminal environment of the twin steers followed a similar pattern during the 28-week period (figure 2). This could help to explain why less variation occurs when twin animals are used in feeding experiments.

SWITCHING RATIONS

Sudden switches in rations — especially concentrate - to - roughage ratios — caused the most noticeable changes in ruminal environment (figure 3). An immediate loss in ability to digest cellulose was apparent when a high roughage ration was switched to high concentrate. The same effect of decreased cellulose digestibility with increased concentrate was demonstrated both in the laboratory and by means of digestion trials with sheep in which cellulose digestion coefficients were determined. It must be made clear that the laboratory artificial rumen was being fed a constant diet of purified cellulose and rumen fluid was taken from ruminants on either high or low roughage. This would indicate that the high or low roughage inoculum used differed in its activity for certain ration components.

Although an animal loses the ability to digest cellulose if fed high concentrate rations, it does not imply that ration components such as starch and protein are not being digested. In fact, the measurements of ruminal temperature and acidity suggest digestive activity. The digestive activity in this instance apparently was less directed toward cellulose and more to the starch component of the ration. In other words, when a ration was switched the digestive action might continue at least as much as usual (unless the switch caused the animal to go off feed) but with a different microbiological attack.

RUMEN MICROBIOLOGY

The effects on rumen environment noted during ration changes may be partially explained by the observed changes in the microbiological population associated with ration switches. Assisted by personnel of the Department of Bacteriology, various methods were used to count and observe the rumen inhabitants both during the ration switches and for day to day differ-

Table 1.
Rate of Gain and Feed Efficiency by Cannulated and Uncannulated Lambs

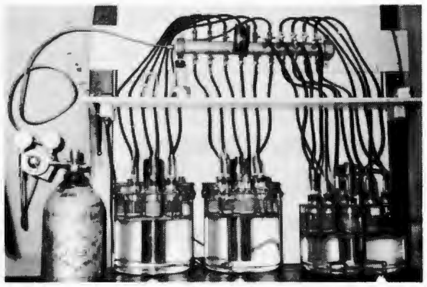
	High Concentrate*		Low Concentrate*	
	Control	Cannulated	Control	Cannulated
No. of animals	10	10	10	10
No. of days	56	56	32	32
Av. initial wt., lb.	89.8	84.1	107.0	103.9
Av. final wt., lb.	108.9	104.9	113.5	112.6
Av. daily gain, lb.	.341	.371	.203	.272
Av. daily ration, lb.	2.80	2.73	3.91	3.91
Feed/100 lbs. gain, lb.	820	736	1923	1437

*The low concentrate ration was fed following the high concentrate phase using the same lambs. 5 days in length preceded by about a 3-week preliminary period.

Table 2. Digestion Coefficients of the Various Nutrients by Cannulated and Uncannulated Lambs*

	Dry Matter	Crude Protein	Ether Extract	Nitrogen-Free Extract	Crude Fiber
			High Concentrate Ration		
Control	62.01	74.10	57.48	72.69	23.51
Cannulated	63.92	74.80	59.52	74.39	26.78
			Low Concentrate Ration		
Control	65.79	76.73	44.38	77.87	38.40
Cannulated	66.47	76.75	42.46	78.43	39.91

*Each value represents an average of 20 determinations using 10 lambs. Collection periods were 5 days in length preceded by about a 3-week preliminary period.

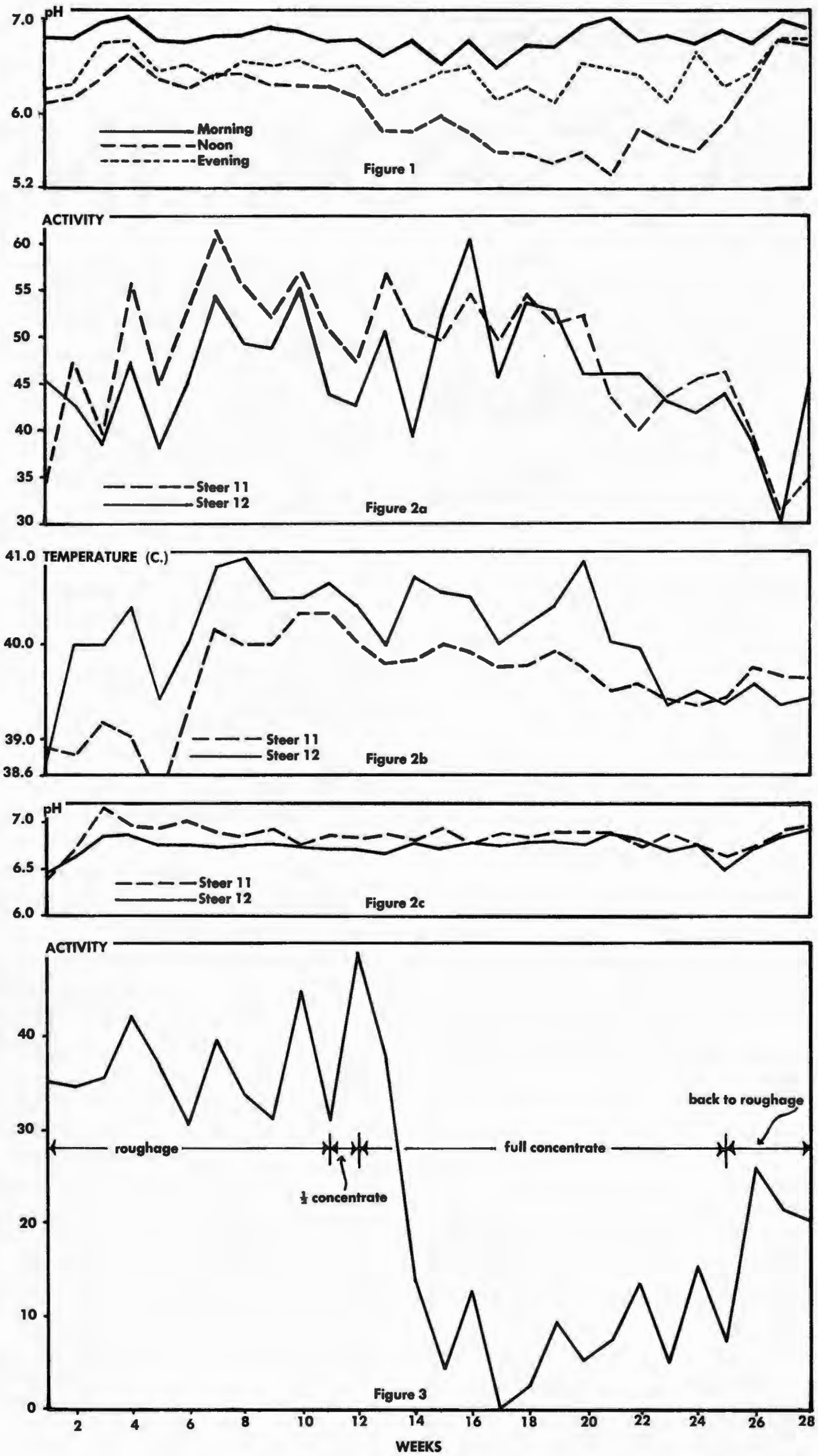


The "artificial rumen" which duplicates the digestive activity of a cow in the laboratory. Continual development of this apparatus has improved its critical measurements and enlarged it to the point where its performance soon will be able to match that of 200 cows.

ences when animals were held to a constant ration.

Although no attempt was made to identify the some 50 species of bacteria and 30 species of protozoa known to exist in the rumen environment, observations were made to check loss or increase in certain basic types of organisms. The rumen fluid from high roughage rations contained more chain and rod type bacteria and larger as well as a greater number of protozoa. Total organism counts between ration types did not differ widely in this study and amounted to about 1 billion per teaspoonful of rumen fluid. The rumen microorganisms were found to be well distributed throughout both the solid and liquid portions of rumen contents. Active inoculum could be obtained for the laboratory digestions (artificial rumen) by using either the rumen fluid directly as taken through the cannula by means of a suction pump or by using the solids pressed free of liquids. The inoculum is obtained from the solids by resuspension in buffer solution to wash the microorganisms from the solids.

Progress is being made in the understanding of rumen function, assisted by development of better techniques for isolation of organisms and methods of maintaining mixed cultures in simulated rumen environments in the laboratory. Much remains to be done to fully appreciate the unique relationship of microbes and the beast which provides a means of nutrition for both. □



These charts from data obtained during the 28 weeks of trials with various cannulated animals may be used for comparisons within each chart. (Scales at left are for each individual chart and do not necessarily reflect comparisons between charts). Figure 1 (top) indicates weekly pH or acidity variations of one cannulated sheep. Comparisons of the cannulated twin steers in figure 2 show (a) values for laboratory measurement of digestive activity; (b) rumen temperatures; and (c) pH. Figure 3 shows how ration switches change laboratory digestive activity in a sheep.

South Dakota's
HOG-PORK INDUSTRY

changes developments problems

By Harlan J. Dirks, *assistant professor*, Economics Department

South Dakota has a real challenge — and opportunity — to move ahead in hog production. But higher standards of performance by producers, processors and specialized hog and pork handlers will be needed to capture a larger share of the national pork market.

Is South Dakota maintaining or improving its competitive position during the changes now taking place nationally in pork production and marketing?

The answers are "yes" in some phases but probably "no" in others.

Hog production is important to South Dakota's economy in several ways:

● hog sales produce over $100 million (about 16%) of the state's annual cash farm income,

● hogs provide a market for nearly a third of the feed grain produced and a large share of the commercial feeds manufactured in the state, and

● for each dollar farmers receive for hogs, at least one more dollar is generated in off-farm businesses, all of which adds to the state's economic growth.

South Dakota is just about holding its own in hog production nationally (see figure 3). In the early 1940's hogs were the most important farm enterprise in the state. Now, cattle sales are roughly three times greater than hogs. This raises questions about the economic health of the hog-pork business in South Dakota—a real cause for concern.

Efficient farm production is essential to the state's competitive position in pork. Likewise, efficient marketing is important for at least two reasons: South Dakota is a major surplus pork producer and its distance from consuming centers. Only 10% of South Dakota's pork production is consumed in the state (figure 1).

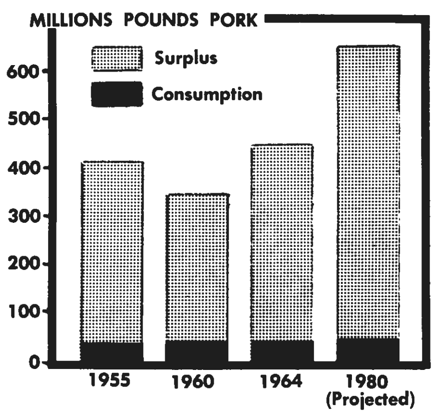


Figure 1. Annual pork production, consumption and surplus for South Dakota.

CHANGES IN MARKET OUTLETS

The relative importance of different slaughter hog market outlets varies by areas of the state, depending largely on type of market available. Producers can sell hogs at 59 auctions, 1 terminal, and 36 direct buying points in South Dakota in addition to those in adjoining states.

Surveys in 1957 and 1964 show a 4% gain in both auction and direct marketings and an 8% decline in terminal marketings (figure 2). This increase in direct or country selling of hogs is similar to the national trend.

Packer ownership of hog buying stations and plants which buy hogs directly have remained fairly constant at 13 in the state for the past several years. Most hogs are bought at the plants although there are six packer buying stations in the state. The number of independent hog buying stations has also been constant in recent years. No data is available for earlier years in South Dakota, but national trends show that hog buying stations are declining in importance. Auction markets have assumed the role of providing local markets for hogs in many areas. The number of stations buying hogs on a direct basis by type for South Dakota in 1965 were:

Dealer stations	23
Packer stations	6
Packing plants	7
TOTAL BUYING STATIONS	36

FEEDER PIG SALES

Feeder pig sales have gained somewhat in South Dakota in the past 7 years but are still relatively unimportant in terms of total volume. Hogs sold as feeder pigs totaled 6% in 1964 as compared to 4% in 1957. An estimated 15% of the nation's hogs start life on one farm and are finished on another. Auction markets are the most important outlet for feeder pigs in South Dakota.

HOG SLAUGHTER CHANGES

The ratio of slaughter to hog production continues to improve in South Dakota. In the 14-year period, 1947-60, an equivalent of 84% of the hogs produced in South Dakota were slaughtered in the state. This increased to 90% in 1964. While some exchange of slaughter hogs takes place along the borders, the net out shipment of live hogs accounts for only about 10% of total production (table 1).

CHANGES IN PROCUREMENT AREAS

Significant shifts in hog production patterns have occurred in South Dakota during the past 25 years (figure 3). These changes have caused concern among packers that hog numbers in their so-called "supply areas" are shrinking. Some packers even now must reach out farther to get their kills.

Hog production is becoming more concentrated in south-central and southeastern South Dakota — the regions which produce the most abundant and stable feed grain supplies. Significant drops in hog production occurred in the West River, north-central and northeastern parts of the state. If past trends continue, 75% of South Dakota's hogs will be produced in south-central and southeastern regions in the next 15 years. Based on projected feed supplies and greater stabilization of feed production, South Dakota has the potential to increase hog production at least 50% by 1980 (figure 3).

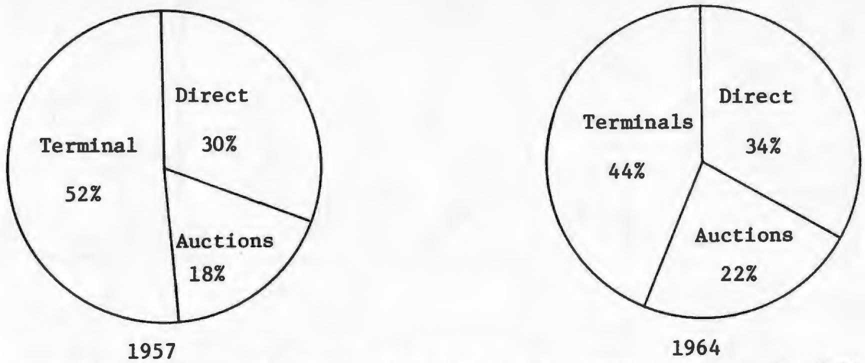


Figure 2. Percentage of slaughter hogs sold through various outlets in South Dakota, 1957 and 1964. (Source: Crop and Livestock Reporting Service.)

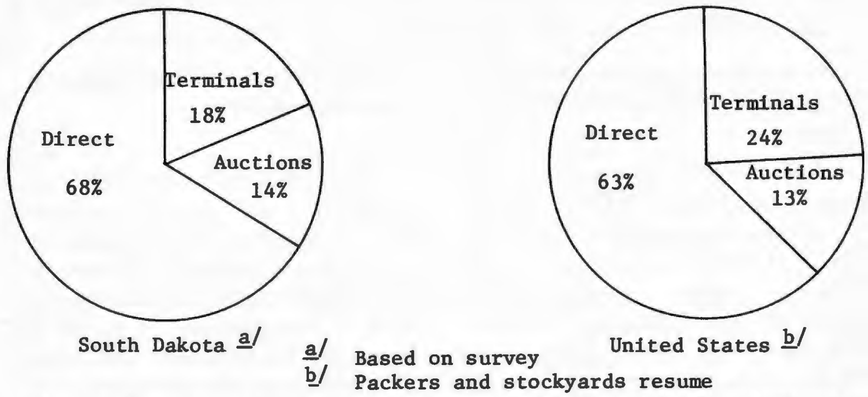


Figure 3. Percentage of slaughter hogs bought by packers through various outlets, South Dakota and United States, 1964.

MORE SPECIALIZATION

Hog production has become more specialized on South Dakota farms. Farms reporting hogs dropped from 60,000 in 1930 to 30,000 in 1960. Meanwhile farms reporting 10 or more sows doubled and those reporting 5 sows or less dropped from 20,000 to 5,000 between 1940 and 1960. But, only 3% of the hog farms farrowed 40 or more litters in 1960. The 1964 census will probably show some gains in larger hog farms.

Specialization is also reflected by frequency of larger loads of hogs delivered to packing plants. A survey and projection showed these totals for most common size lot per one owner delivered to plants in South Dakota: 1960 — 18; 1965 — 22; and 1970 — 26.

Packers have noted a trend toward more uniformity in marketing, but incoming loads are still mixed with respect to grade, weight and market classes. Generally, hogs are not sorted into grades before slaughter, but rather wholesale cuts are graded on the cutting floor. More uniformity of marketed hogs would help both in reducing handling costs and increasing value of the finished product.

Table 1.
Hog Production vs. Commercial Slaughter in South Dakota for Specified Years*

	Thousands Head				
	1947-60 Ave.	1961	1962	1963	1964
Hog production†	2,480	2,715	2,817	2,968	2,845
Commercial slaughter	2,090	2,308	2,451	2,654	2,547
Ratio of slaughter to production	.84	.85	.87	.89	.90

*South Dakota Crop and Livestock Reporting Service.
†Based on pig crop from previous fall and following spring.

SEASONALITY OF SLAUGHTER

Despite greater specialization, 65% of the sows are still farrowed in the December-May months. This has caused heavy fall and winter marketing and considerable seasonality in hog slaughter (figure 4). However, improvement can be

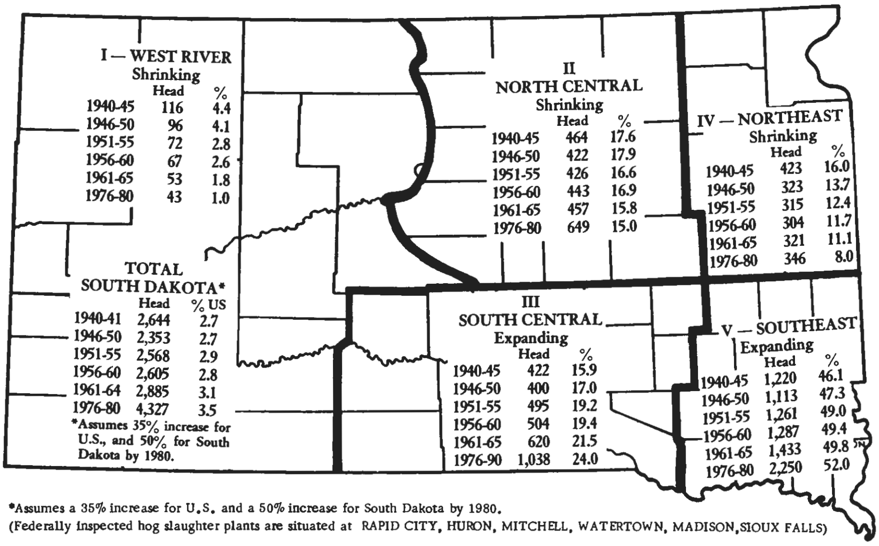


Figure 4. Annual pig crop (thousands head) and percent of total state production by regions in South Dakota, 1941 to 1964, projection to 1980.

noted in the past 18 years. In the 9-year period from 1947-55, the index of monthly slaughter showed a high of 152 for December and a low of 71 for August – a range of 81 points. In the following 9 years, 1956-1964, the index dropped to 125 for December and 80 for August – an improvement of 36 points in the high to low range.

Along with seasonality, there is the problem of year-to-year or cyclical fluctuations. In a recent cycle, the high to low variation in hog marketings was nearly a million head. In 1959 some 3.1 million hogs were marketed; this dropped to 2.2 million in 1960. Part of this variability is due to ups and downs in feed production, as evidenced by greater variability of hog production in the drier areas of the state. However, much of the problem is still related to many smaller producers who get in and out of the hog business depending on price levels.

QUALITY IMPROVEMENT

A sizeable improvement is evident in number of meat-type hogs slaughtered in South Dakota (table 2). An estimated 37% of market barrows and gilts slaughtered in the state's plants would have graded U. S. No. 1 in 1965. This is an increase of 9% in 5 years. Based on past progress, packers estimate that 45% of the hogs would grade U. S. No. 1 by 1970.

While this has been substantial progress, a study by USDA showed that a third of the market hogs would have graded U. S. No. 1 in the United States some 5 years ago. Part of the problem in South Dakota may be related to the weights at which hogs are marketed – producers in this state market hogs more than 20 pounds heavier than the national average (figure 5). This could drop many from the top grade.

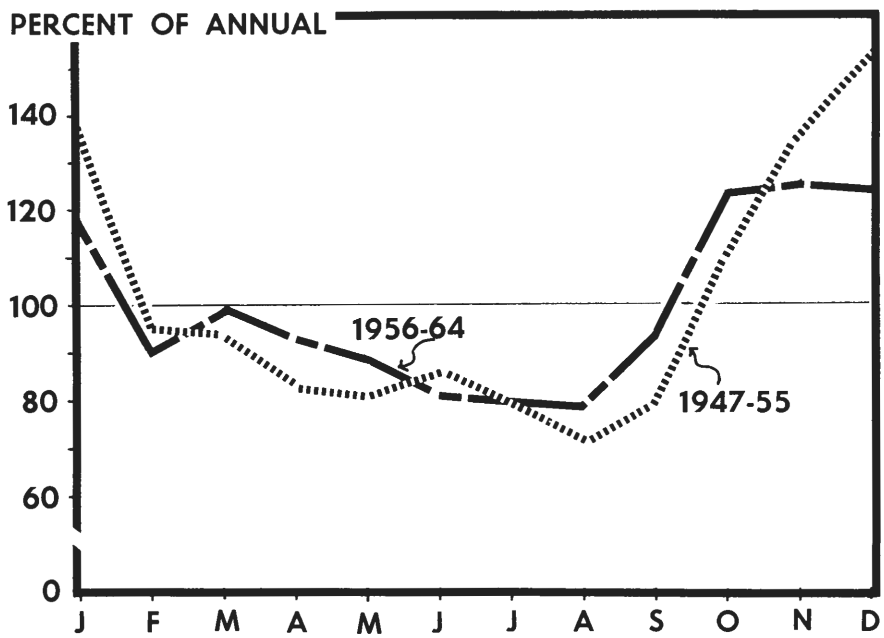


Figure 5. Monthly index of hog slaughter in South Dakota 1947-55 and 1956-64. (Source: Crop and Livestock Reporting Service).

Table 2. Estimated Grade of Market Barrows and Gilts Slaughtered in South Dakota*

Grade	1960 (Past)	1965 (Present)	1970 (Projected)
	(Percent of Slaughter)		
U. S. No. 1	28	37	45
U. S. No. 2	47	44	43
U. S. No. 3	20	15	9
Other	5	4	3

*Based on survey of packers.

GRADE AND YIELD BUYING

Grade and yield buying of hogs has not caught on to any extent in South Dakota. A survey of packers shows that only about 2.5% of the hogs are currently bought on a grade and yield basis. This percentage is about the same as for the United States as a whole, but slightly below the region. Packers and stockyards reports show that about 5% of hogs were purchased on grade and yield in the West North-Central Region in 1961. No doubt some gains have been made since.

TRANSPORTATION COSTS

If pork processing is to thrive and remain competitive in South Dakota, transportation rates on fresh meats must also be competitive. Rail rates for shipping fresh pork

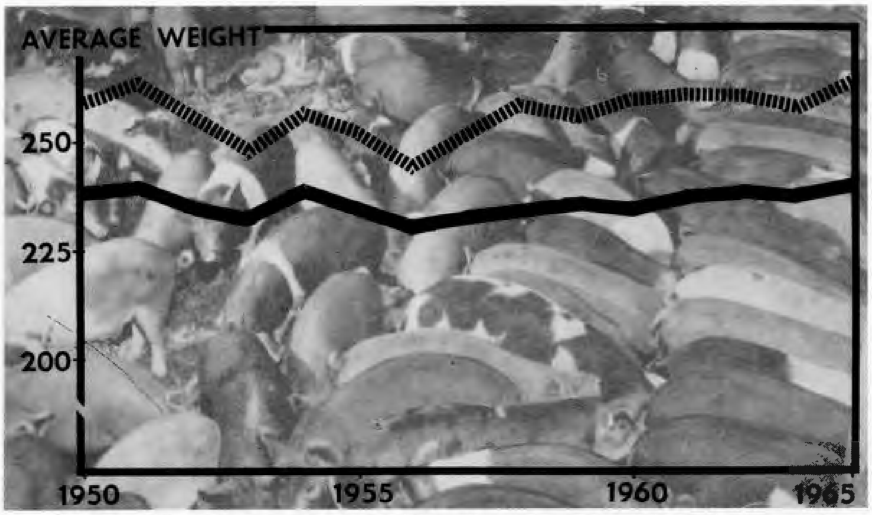


Figure 6. Average market weight of slaughter hogs per head for U. S. and South Dakota, 1950-65.

from South Dakota dropped 20% between 1957 and 1963. However, rates for South Dakota have dropped relatively less than for other West North-Central States. For example, rates on fresh meats dropped 5% more in Minnesota, 4% more in Nebraska and 3% more in Iowa than in South Dakota over this period. This is important because the producer usually absorbs higher marketing costs.

One bright spot in the changing rate structure is that rates for fresh meats have dropped relatively more than for live hogs. South Dakota ships a number of live hogs out of state — some as far as the West Coast. But from the standpoint of transportation costs, South Dakota can put dressed pork on major markets cheaper than live hogs. The cost of shipping live hogs, the equivalent pork rates, and actual fresh pork rates are summarized in table 3.

Table 3. Rail Freight Rates for Live Hogs, Equivalent Pork Rates, and Actual Pork Rates, Per cwt.*

	Destination				
Origin	Los Angeles (West)	Portland (Northwest)	Chicago (Midwest)	New York (Northeast)	Raleigh (South)
	(dollars per cwt.)				
Sioux Falls					
Live hog rate†	1.94	1.66	.77	2.02	1.95
Equivalent pork rate‡	3.23	2.77	1.28	3.37	3.25
Fresh pork rate§	2.64	2.54	1.16	1.91	1.66
Huron					
Live hog rate	1.94	1.66	.87	2.12	2.05
Equivalent pork rate	3.23	2.77	1.45	3.53	3.42
Fresh pork rate	2.64	2.48	1.30	1.90	1.88
Sioux City					
Live hog rate	1.76	1.71	.77	2.02	1.95
Equivalent pork rate	2.93	2.85	1.28	3.37	3.25
Fresh pork rate	2.60	2.60	1.12	1.91	1.65

*Based on rates supplied by FCS, USDA.
†Double deck, per hundred weight.
‡Equivalent pork rate is determined by dividing live hog rate by (.60), average yield of pork, excluding lard per head.
§Actual transportation and mechanical refrigeration charges for shipping carloads of fresh pork based on 35,000 pounds.

HOG-PORK INDUSTRY GOALS FOR SOUTH DAKOTA

- Stepped up hog production. At least a 50% increase by 1980 for greater utilization of surplus feed grain supplies and to improve the state's economic base.
- More specialization in hog production — an increase in units with a minimum of 20 to 25 sows using a multiple farrowing system. This will be needed to achieve cost economies and to stabilize slaughter supplies.
- Greater efficiency in production. Reduce the present 466 pounds of grain (not including pasture) needed to produce 100 pounds of pork to 400 pounds or less. If production costs could be lowered only 10c per hundredweight, it would save South Dakota producers about $750,000 a year.
- More progress in disease control. Economic losses from diseases are currently costing producers about $2 million a year.
- Greater improvements in meat-type hog production. A goal of no less than 75% of the market barrows and gilts grade U. S. No. 1 by 1980.
- An industry goal of developing a marketing system which will bring more order and efficiency into the marketing process, and a pricing system which more accurately reflects the true value of hogs.

An Organic Trench

That lets moisture and air (and ROOTS!) go through claypan soils.

Q. S. Kingsley, assistant professor, and F. E. Shubeck, associate professor, of the Agronomy Department at South Dakota State University, report on their claypan soils research in more detail in Agricultural Experiment Station Technical Bulletin No. 26, "Effect of Organic Trenching on Grain Yields, Soil Moisture and Root Penetration in South Dakota Claypan Soils." Copies of this publication may be obtained through your South Dakota Agricultural Extension Service county agent or by request to the Bulletin Room, South Dakota State University, Brookings, S. Dak., 57006.

Organic trenching is a comparatively new mechanical technique being used in South Dakota research efforts to boost crop yields on claypan soils.

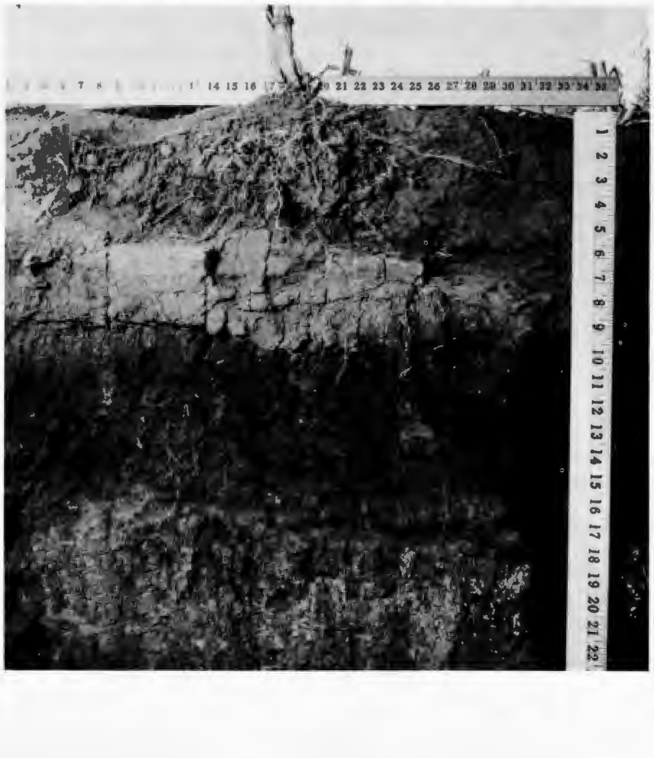
The experiments are aimed at solving a problem caused by a dense, nearly impervious layer (the "claypan") in these soils. This claypan decreases water infiltration, air exchange and root penetration. Agronomists say a third of the soils in some central and western South Dakota counties have a claypan in the profile. Some of the clay layers are so dense, investigations show, that it would take a year for 34 inches of water to penetrate them. They may range up to several inches in thickness and extend in irregular patterns causing "checkerboard" appearance in growing crops.

Encouraging results have been obtained by "opening" these clay layers with a continuous wedge of organic material placed in a vertical fracture running from the soil surface to a depth of about 20 inches. The wedge of organic material keeps the claypan open so that moisture and air — and roots — penetrate deep into the strata below. This is an advantage over some other, mechanical treatment methods which give only temporary benefits because the fractured claypan again becomes impervious after heavy rains.

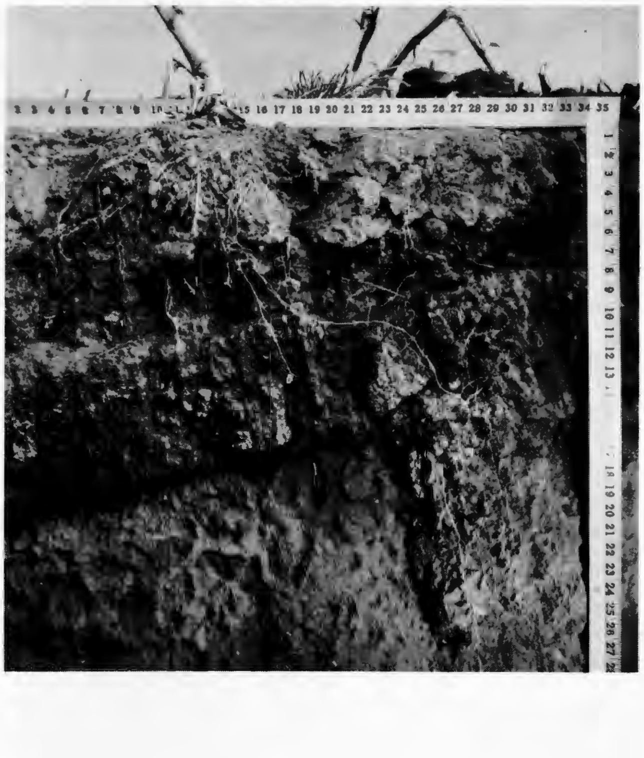
Trenches were made at 84-inch intervals by a subsoiling chisel with a pair of iron "wings" bolted to the sides to hold the fractured soil open until organic matter had been placed in the cavity. Organic materials were placed in the trenches by hand during this experiment, however, equipment is now available which will pick up, chop, and blow the organic material into the trench.

Briefly, here are some of the find-

Corn root growth in a no treatment plot. Most of the root activity is restricted to the upper 6 inches. Any roots below the 9-inch area or claypan are fibrous and small. Few roots extend below the 15-inch area or bottom of the claypan.



Corn root growth in an organic trenching treatment. The corn cobs may be seen clearly in the 6- to 14-inch area. The cobs and roots extend through the claypan in this view showing the projected portion of the claypan.



Two profiles showing the claypan horizon on the left and the organic wedge of straw on the right.

A mass of corn cobs removed from the trench after being buried for 3 years.

ings of the research conducted in Spink County:

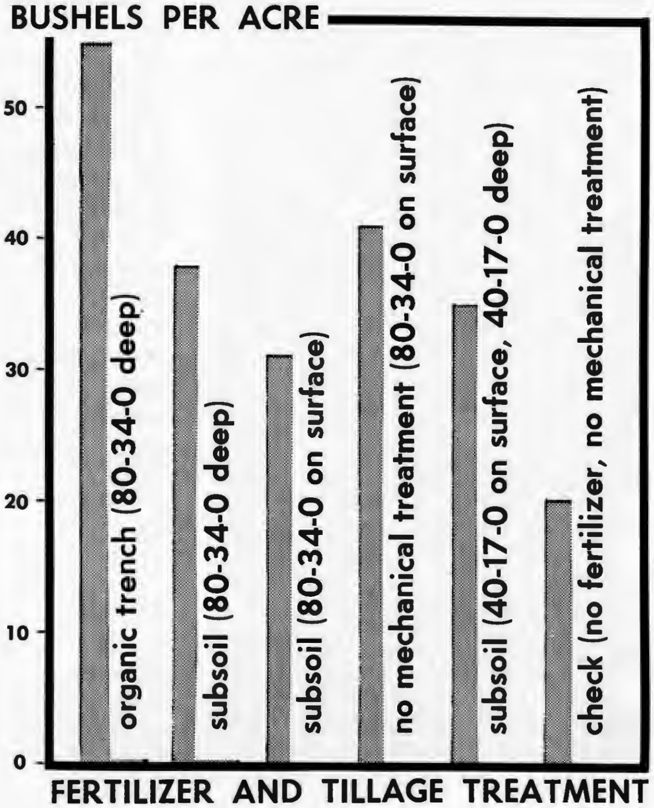
ORGANIC MATTER DURABLITY

Out of four materials used, wheat straw in the trench had decomposed most at the end of 3 years. Next in order of increasing durability (although the rate was small) were sweet clover, corn cobs, and flax straw. Corn yields were higher the third crop year than the first year in experimental plots where corn cobs, flax straw and wheat straw were used. Sweet clover in the trench gave highest first-year corn yields but did not have the prolonged beneficial effect of the other residues which had wider carbon-to-nitrogen ratios. Residual effects from placing organic matter in the trench resulted in greater yield increases than by spreading the same amount of organic matter on the surface and plowing it under.

Weight of roots per acre increased in the organic trenched plots, compared with check plots, with only one exception. This exception was at the 0—1 foot level in the corn row which was also the

RIGHT — Effect of fertility and tillage treatments on yield of corn in a corn, wheat, rye sequence.

BELOW — Trenching tool mounted behind tractor. Bale of straw shows size comparison.



UPPER PHOTO — Vertical stakes are in area between organic trenches and middle of lined board is centered over the trench. Trench runs at right angles to the board. LOWER PHOTO — Vertical stakes are in the trenches that contain no organic matter and middle of board is centered over area between trenches.

point farthest away from the organic trench. However, at this depth root weights increased as sampling locations neared the trench.

VARIOUS METHODS COMPARED

Organic trenching appeared to benefit corn yield the first crop year while subsoiling and trenching without an organic wedge did not. Wheat yield was low the first year, possibly because of heavy rainfall and the moisture collecting characteristics of the organic trenches. Subsoiling appeared to increase wheat yields slightly.

In the third year commercial nitrogen, sweet clover catch crop and subsoiling all appeared to increase corn yield. Both organic trenching and sweet clover catch crop treatments substantially increased yields of rye the third year. No yields were obtained in the second crop year because of severe hail damage. For this reason rye was substituted for wheat in the cropping sequence.

INFLUENCE ON SOIL MOISTURE

Probably the most striking effect of organic trenching was its efficiency in increasing infiltration and conservation of moisture in claypan soils. The loss of water by runoff and evaporation constitutes one of the major problems of crop production on claypan soils.

In the organic trenched experimental plot there was more total available water (especially at lower depths) than in plots without the trenching. This indicates that the organic wedge was successful in increasing water infiltration.

PLACING FERTILIZER DEEP

A combination of organic trenching and deep-placed fertilizer boosted corn yield considerably over that of check plots. The trenching - deep - fertilization operation was done once, at the outset of the experiment. Fertilizer was placed deep in the soil when the claypan was held open by the wedging machine. □

maize dwarf mosaic

By C. M. Nagel,
professor and head
Plant Pathology Department

Maize dwarf mosaic, the new virus disease of corn which broke out in the eastern Corn Belt in 1963, was found in one county in southwestern Iowa about 75 miles south of the South Dakota border in August 1965.

However, to date, the disease has not been found in South Dakota.

Because of the serious threat, a rapid expansion of research on maize dwarf mosaic is underway in several experiment stations, particularly in states where the disease was first found. Much has been learned which will be important in the search for practical controls.

Inbred corn lines, developed by the South Dakota State University plant pathology department for resistance to root rot and stalk lodging, were sent to Ohio and Indiana experiment stations for testing against maize dwarf mosaic. Fortunately, results indicate that considerable resistance to maize dwarf mosaic is present in a few of the 150 different inbred lines tested.

SEEK HELP OF GROWERS

Growers can help South Dakota Agricultural Experiment Station plant pathologists keep tab on the new disease should it spread into this state. They are asked to notify the plant pathology department at SDSU if they notice plants in their fields that have symptoms of maize dwarf mosaic. (To help avoid possible danger of spreading the disease, do not bring or send actual plant samples).

First leaf symptoms appear as a rather indistinct light to dark green mottle pattern on the youngest unfolding leaves when the plants are about a foot high. As growth continues the young leaves turn yellowish-green, followed by various shades of red. Late season infection permits ear development but poor kernel set. The virus can be transmitted from one plant to another in the field by at least 11 different species of aphids and by mechanical means in greenhouse experiments.

Main damage from the disease is serious dwarfing or shortening of the upper internodes and failure to set ears. Or, if ears are set, only a small amount of seed is produced, depending on the stage of growth of the corn plant when virus infection occurs. Once infection occurs the virus spreads throughout the plant in about 10 days. From then on plant growth is slowed down and serious damage results.

JOHNSONGRASS, ONE SOURCE

No evidence as to the presence of the disease was obtained in special 1965 corn experiments at six different locations in the southeastern quarter of South Dakota. However, Johnsongrass, which is also very susceptible to this virus disease, was found growing wild in southeastern South Dakota. Johnsongrass is a perennial wild sorghum which grows 6 to 8 feet tall and has a below-ground root system which apparently survives the winter. In states where maize dwarf mosaic is found, Johnsongrass is usually present and infected. It serves as the source of spread of the virus to corn during the growing season, and, most important, the virus can overwinter in the perennial roots of Johnsongrass. The potential of Johnsongrass becoming infected and turning into an overwintering source of the disease is a reasonable possibility in South Dakota.

FOUND IN 12 STATES

Maize dwarf mosaic on corn up to last fall had been found in Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, Nebraska, New Jersey, Ohio, Pennsylvania, and Tennessee. Greatest rate of spread was in Ohio in 1964. Intensity and spread in 1965 was somewhat less serious in states where previously found.

Plant pathologists in other states have also been testing hundreds of inbred lines and hybrids at a rapid rate in order to find sources of resistance to the disease. As a result, a comparatively small number of inbreds and hybrids have been uncovered as having encouraging sources of resistance. These are now being used in the development of new hybrids which may possess sufficient resistance to markedly reduce the damage to one of the nation's most important crops from this potentially destructive disease. Indications are that it may be possible to develop tolerant or resistant hybrids from presently adapted corns without needing to go to "wild" corn for sources of resistance. The latter would require many more years of research and testing before a commercial hybrid could result.

On the basis of screening experiments to date, indications are that most commercial hybrids now being grown in Corn Belt states are susceptible to maize dwarf mosaic. Obviously, should the disease become widespread, the losses in corn yield could be serious to farm income and livestock production in the United States. □

Mottled appearance which is one of the first symptoms of maize dwarf mosaic in the young unfolding leaves at the early stage of the disease. (Photo courtesy of Pennsylvania State University).

A New Industry?

BAIT FISH

By NORMAN D. SCHOENTHAL,
assistant professor,
Wildlife Management Department

Expected continuation of the ever - increasing popularity of sportsfishing in South Dakota means that output of the bait fish industry must be boosted. And, a planned orderly expansion of this industry, in turn, could add a sizeable amount of new business to the state's economy.

Fishing license sales in 1959 totaled 140,000 and by 1964 the number sold in South Dakota had risen to 198,500. This increase is due to a combination of factors: more non-resident participation, faster means of travel, more leisure time, rising economy and, probably most important, a tremendous increase in fishing waters stemming from construction of dams. As a result the live bait industry within the state is faced with growing demands.

Before this increased demand was placed on the industry, the supply was easily met by harvesting bait fish from public waters. But public waters can no longer assure the supply to fill the additional demand. During certain seasons, as a result of fish behavior, bait fish tend to congregate and they can be easily harvested to amply supply the demand. However, during other seasons bait fish become widely dispersed or move to habitats where they cannot be harvested in sufficient numbers to meet the demand. The fisherman must be assured of a readily available bait supply of desirable species (fathead minnows and suckers, for instance) of all sizes during the year to insure the greatest utilization of our sport fish resources.

COMMERCIAL RAISING OF BAIT FISH

The industry in the near future must turn to commercial raising of bait fish in private waters for several reasons. First, commercial raising is the only means by which desirable bait fish species can be marketed throughout the year. This is accomplished through stocking ponds and sloughs at different times of the season and at different rates. Second, producers can achieve greater control over the quality of the bait fish that are marketed. Quality here refers to healthier fish which will survive longer in the retail dealer's holding tanks and ultimately in the fisherman's minnow pail. Another aspect of quality control is that the marketed product not be contaminated with undesirable fish (such as carp, brook stickleback and certain minnows) which die when confined in holding tanks thus creating disease problems. Third, within a few years the public waters will be closed to minnow harvest. The removal of tons of forage fish (minnows) annually from lakes cannot continue without having some adverse effect on sport fish such as bass, northern pike and walleye.

Bait fish production is a complicated process. Only one early phase of raising them is shown here. Fish eggs in batteries of jars are constantly agitated by circulating water of the right temperature which also supplies oxygen. The water overflowing from the jars carries the newly hatched fish into a large tank. Later they are removed from the tank and taken to rearing ponds.

Commercial raising of bait fish started in the more populated areas of the East and South and gradually moved towards the Dakotas. The wholesale bait dealers in the Dakotas have two alternatives: either go into commercial raising of bait fish or import the bait from states with commercial bait enterprises. The first alternative would seem the more feasible, plus adding to the economy of the state.

A COMPLEX OPERATION

Commercial bait fish farming is in its infancy in South Dakota. Five operators are presently in some phase of production. However, in 1965 most of the bait handled by the 19 licensed wholesalers and 236 retailers within South Dakota was taken from public waters or imported from Minnesota.

Bait fish production is far more complex than most people realize. For example, the white sucker, commonly referred to as the chub, is handled between six and eight times before it reaches the retailer's tank. This includes stripping eggs from the adults, hatching, stocking fry in the production ponds, harvesting the production ponds, stocking winter holding ponds, harvesting from winter holding ponds, grading fish in the plant and transporting to the retailer. The fathead minnow, another common bait fish used in South Dakota, is handled between four and six times. Other phases of the operation include selection of new production ponds, chemical analyses of water, eradication of undesirable fish from ponds by chemical means, disease prevention, detection and treatment and continual experimentation in production and harvest to produce a better bait fish at a greater profit.

The South Dakota State University Wildlife Management Department through the Agricultural Experiment Station will soon publish a bulletin dealing with bait fish production. Also to be published is information on retailing bait fish and raising nightcrawlers.

Capital investment in a bait fish operation will range from $50,000 to $150,000. Some operators in Minnesota have investments of nearly a quarter of a million dollars. Most of these operations have three to six permanent employees and additional help during the spring rush period. Annual operating costs run from $25,000 to $50,000 for a full scale operation.

ORDERLY DEVELOPMENT NEEDED

Because the future of the bait fish industry depends upon commercial raising of bait fish in private waters, cooperation is needed between the wholesale and retail bait dealers, the South Dakota Game, Fish and Parks Department, the State University Agricultural Experiment Station, and ranchers and farmers of South Dakota. Here are some of the advantages and possibilities which will result from this cooperation:

- Benefit from accomplishments and mistakes made in other bait fish producing states.
- Develop regulations helpful to bait dealers, sportsmen, Fish and Game Department, and other parties concerned.
- Set up quality standards for the fish marketed.
- Develop methods for greater production of fish in South Dakota waters.
- Develop more economical means of harvesting bait fish.
- Develop a market in other states for bait fish produced in South Dakota.
- Through genetics develop new strains of bait fish species that are now dominant and determine if other species of minnows can be used.

It is quite likely that this industry could expand into a million dollar annual business without jeopardizing our aquatic resources. □

INSECT OUTLOOK

(See this and three following pages)

Watch for Clues

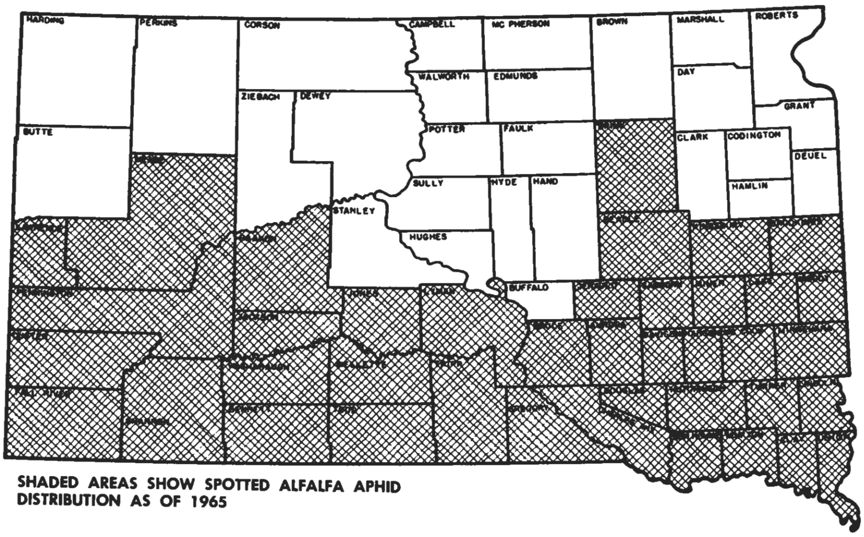
So many factors are involved that it's not easy to predict where and when insect pests are liable to strike.

But you can be on the lookout for certain clues which may be useful. They might give you just that extra advantage to stave off excessive losses. In regions where some insects are annual pests to varying degrees, entomologists are able to establish certain guidelines as to what might be expected to happen under certain conditions.

Experiment Station and Extension Service entomologists at South Dakota State University keep close tab on all major insect pests in the state. Extensive surveys are conducted, much of the time in cooperation with county agents. Entomologists then issue an annual summary of insect conditions for the previous year and, where possible, forecast what might be expected for the next year.

Some clues which may help you are in the accompanying maps showing grasshopper and corn borer infestations for 1965. Normally the clue here is that where fairly heavy infestations occurred the previous year, chances are likely that the insects will appear in damaging numbers the following year. Early killing frost over most of the state in the fall of 1965 is expected to reduce the threat from the corn borer in 1966. In the case of corn rootworm, entomologists have observed that in South Dakota they are advancing northward at the rate of about 60 miles a year. Danger areas can be fairly well predicted.

Weather may offer you another clue. For instance, if it is cool and cloudy this spring in western South



SHADED AREAS SHOW SPOTTED ALFALFA APHID DISTRIBUTION AS OF 1965

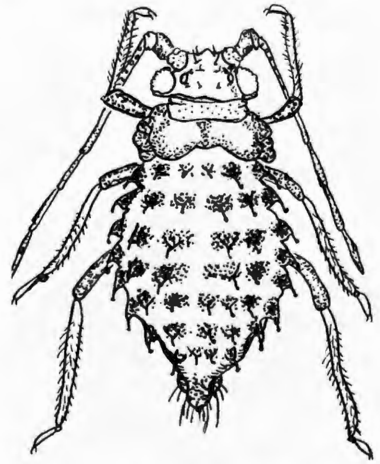
Dakota, look out for alfalfa weevils. On the other hand, if it is hot and dry in eastern South Dakota, farmers there may find that spotted alfalfa aphids pose a serious threat.

Other clues may be found in the nature of the insects themselves. These clues, however, usually are only apparent to entomologists or persons with special training. Take, for instance, the spotted alfalfa aphid, first found in this state in 1956 and which has been collected as far north as North Dakota.

For several years this pest was not considered dangerous as far as damage to crops was concerned. Why? Because the earlier forms were asexual or non-egglaying. But now the egg laying form (first found in 1961 in Charles Mix County) has moved as far north as northern Spink County. It has spread east and west so that it now extends completely across southern South Dakota.

The situation as far as potential damage is concerned is changed because the spotted alfalfa aphid can overwinter in South Dakota. In recent years natural enemies (ladybugs, lacewings and others) have pretty well controlled the spotted alfalfa aphid in South Dakota. But a sudden hot, dry spring would be ideal for the hatching of aphids—and the aphid predators are not present at that time.

These maps may give you an idea of what to expect and prepare for. Your county agricultural extension agent can give you more details about these and other insects. □



Spotted alfalfa aphid. Life-size about 1/10th inch.

Push Research on Control of

ALFALFA WEEVIL

By Robert J. Walstrom,
professor and head
Entomology-Zoology Department

Alfalfa weevils didn't expand into new territory in western South Dakota in 1965, but where they were (especially in the northern Black Hills) they increased tremendously in numbers. The fact they didn't spread last year as in previous years, is one of the few encouraging aspects of the problems they cause.

Up to 100% losses occurred on first crop alfalfa and 50% on the second cutting in some fields of most heavily infested areas. In the system used by entomologists to make insect counts (number taken per 100 net sweeps, for instance) here is how the alfalfa weevils increased in one of the check areas: 20-40 adults early in May; 75-135 adults 5 weeks later (compared with only about 5 in 1964); and 2,500 larvae in July. Over-all, the pest re-established itself as an economically important insect in the western part of the state.

A cool and cloudy spring in 1966 could mean further damage.

Entomologists at the South Dakota Agricultural Experiment Station have stepped up efforts the past 2 years to find suitable materials to control or at least blunt alfalfa weevil damage. They have virtually had to start from scratch because of federal bans on use of chlorinated hydrocarbon insecticides. Residue problems caused the bans.

At present, South Dakota research is concerned with investigating short residue materials which previously had been avoided because of their hazard to the applicator. It means that while seeking control for weevil, the investigators must continually emphasize the danger in handling these chemicals. If parathion — one of the most promising chemicals — is used, only trained people should apply it. Additionally, parathion-treated alfalfa must be left at least 15 days before cutting.

The alfalfa weevil, an immigrant from Europe, was first noted in the United States near Salt Lake City, Utah in 1904. Its larval form causes the most damage: feeding on growing tips, leaves and buds of alfalfa. The pest may destroy most of the feed value of a hay crop or prevent profitable production of seed. It is essentially a pest of first-growth alfalfa. But when first-growth is cut for hay, weevil larvae feed on basal shoots and retard the second growth — especially serious in dryland farming or second-crop seed production.

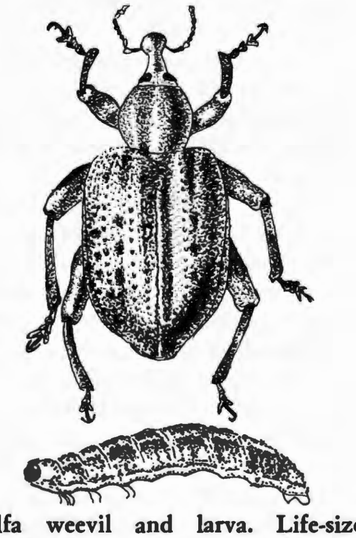
Several lines of attack may be considered: kill off overwintered adults, destroy larvae, use cultural practices, and encourage natural controls.

KILLING OVERWINTERED ADULTS

Overwintered adult females lay their first eggs soon after snow melts, in the new alfalfa stems. Hatching usually begins in April and larvae begin to cause damage in late May or early June, about the time the first growth of alfalfa produces buds.

Most farmers would welcome a

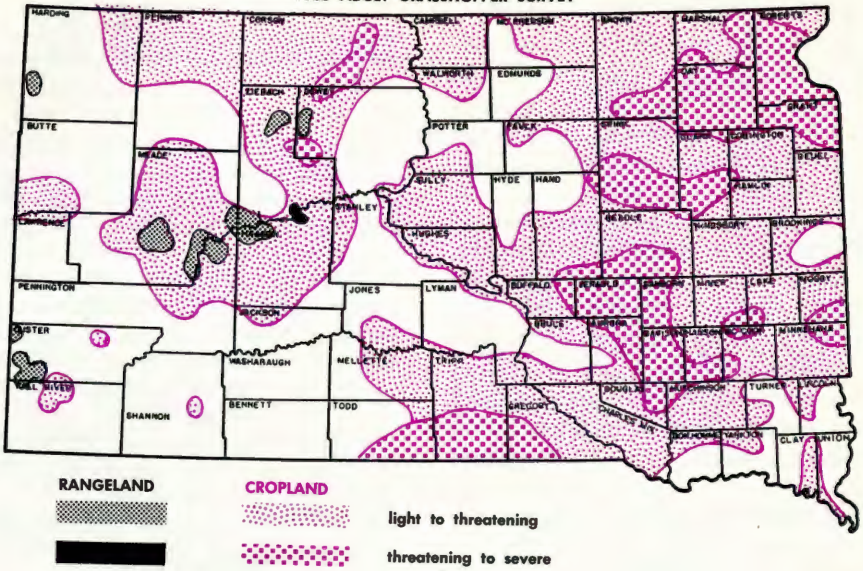
(Continued Page 30)



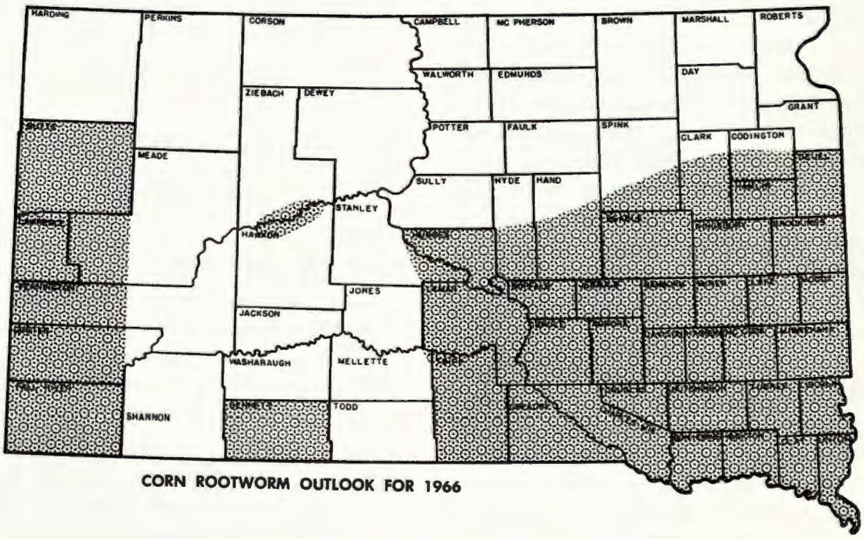
Alfalfa weevil and larva. Life-size (weevil) about 3/16th inch, (larva) about 1/4th inch.

GRASSHOPPERS. Increase in grasshopper numbers in eastern South Dakota probable in 1966. An extended warm period last Fall resulted in additional feeding on late crops and for continued egg laying. Weather in 1966 will be key factor. Watch out if weather is warm and dry. (Last year's long, cool spring and relatively wet summer minimized grasshopper damage to both crops and range land plants). Danger period: late June through July.

1965 ADULT GRASSHOPPER SURVEY

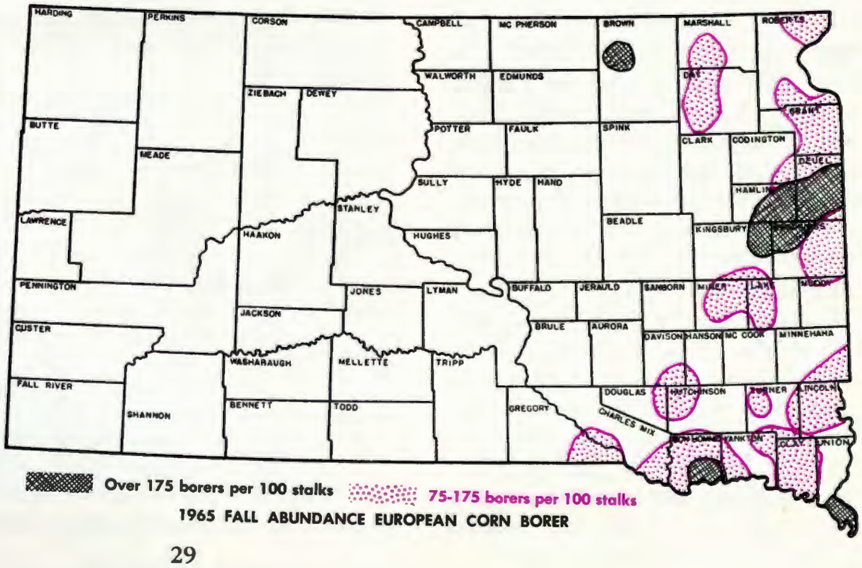


CORN ROOTWORM. Although fewer concentrations of rootworm adults and less evident damage in corn fields in 1965, there were still sufficient adults to deposit eggs in the soil so that economic populations of corn rootworms can be expected in 1966. Of greatest concern to South Dakota farmers are two inter-related species, northern and western corn rootworms. Different insecticides are used for control of each of these species. Danger period for root-eating larval form: mid-June through July; for adults (which interfere with pollination at silking time) late July, August.



CORN ROOTWORM OUTLOOK FOR 1966

EUROPEAN CORN BORER. Fall abundance survey of larvae in corn fields in eastern South Dakota indicates borer population, based on average number of borers per 100 stalks, has declined for third straight year. Exceptions were Deuel-Hamlin County areas and along southern edge of the state in Bon Homme, Yankton, and Clay Counties. Localized infestations classed as spotty. Except for Deuel County, little evident damage to corn caused by second brood borers. Nearly all observed field damage was by first generation corn borers. Danger period: July through September.



1965 FALL ABUNDANCE EUROPEAN CORN BORER

ALFALFA WEEVIL, From Page 28

method for winter-treatment for control. For one thing they could apply insecticides during a slack season. This would nip the damage at the start by destroying egg-laying females.

But so far winter applications of short residue chemicals (Thimet, diazinon, and malathion) have not given adequate control. Fall 1965 applications of some short residue insecticides were aimed at killing the adults before they even got set for winter. Results of these initial attempts are to be evaluated this June.

DESTRUCTION OF LARVAE

Killing larvae in May or June offered good possibilities until the federal ban on chlorinated hydrocarbon insecticides. This means investigating new insecticides, when and how to use them.

South Dakota investigations have indicated that spring foliage spray applications of short residue insecticides did not give thorough controls. But foliage treated by diazinon, Sevin, diazinon+methoxychlor and malathion+methoxychlor did show favorable plant growth effects when compared with untreated areas. Low volume concentrate and regular emulsion sprays of malathion by air application were unsatisfactory in 1965 tests on heavy foilage.

However, ethyl parathion emulsion aerial applications at 6 ounces per acre gave 99.3% control on initial trials and proved most economical on the growing first crop in the bud stage. Ground sprays of malathion+methoxychlor, Guthion, and Sevin gave good control on stubble in early July. Good results have been obtained also with chemicals so new that manufacturers have not yet decided on commercial production and obtaining USDA approval for their use.

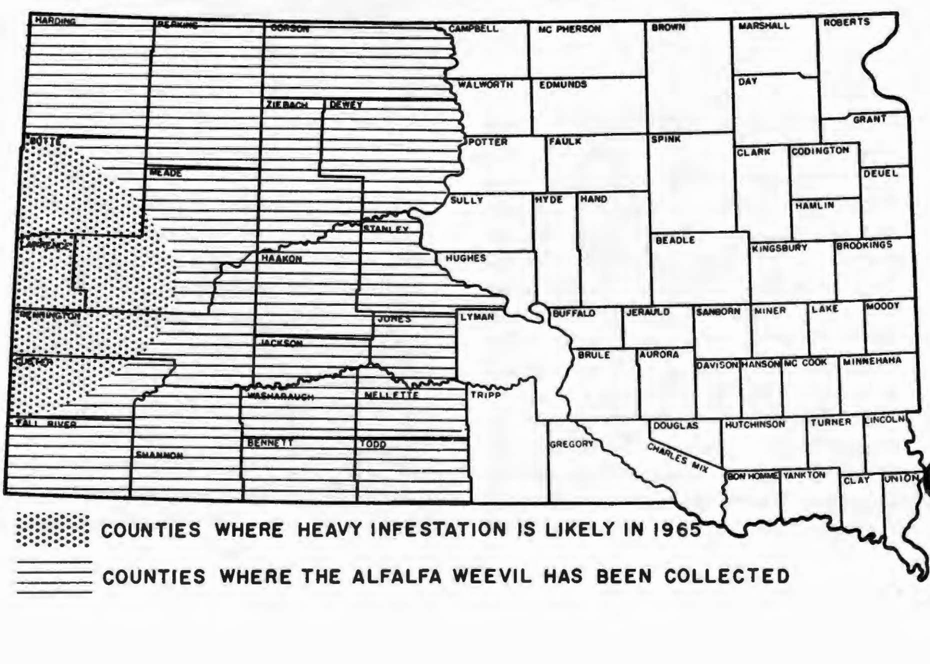
CULTURAL PRACTICES

Early cutting of the first and second alfalfa crops in some cases is advantageous and is a measure fairly widely used. But this method has its drawbacks if done every year, as it should be done for best control. For one thing, continual early cutting tends to reduce the alfalfa stand. Weather conditions are not always conductive to this practice either.

NATURAL CONTROLS

A tiny wasp, known scientifically by the big name *Bathyplectes curculionis*, is an ally of man in killing alfalfa weevil larvae. Commonly called the weevil parasite, this insect is a factor in control of alfalfa weevil – the damage would be much greater without them. About 75% of the larva in the South Dakota test area were parasitized by the little wasp in 1965. (Parasitized larvae die in late-May after spinning their lacelike cocoons on fallen leaves on the ground). Entomologists are anxious to know also just what might happen to this beneficial insect under certain alfalfa weevil control conditions with new insecticides. Incidentally, the tiny wasp was imported from Italy in 1911-13 for the specific purpose of helping control the alfalfa weevil.

KNOWN DISTRIBUTION OF ALFALFA WEEVIL IN SOUTH DAKOTA



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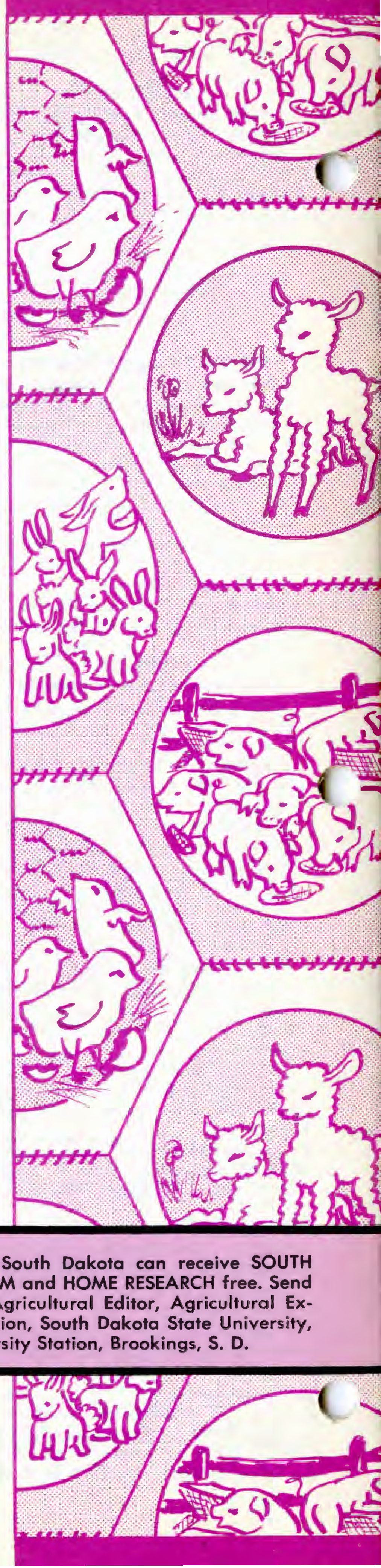
This index for South Dakota *Farm & Home Research,* the quarterly research progress report of the South Dakota Agricultural Experiment Station, is for calendar years 1964 and 1965.

Copies of the quarterly for this period are available in limited numbers and may be obtained by writing the Agricultural Editor, South Dakota State University, Brookings, South Dakota 57006.

CROPS

Check your fields about mid-June and after to see if your corn plants have symptoms of maize dwarf mosaic similar to those shown on the three leaves at left. For comparison, a normal, healthy leaf is shown at right. See article beginning on page 24. (Photo courtesy of Pennsylvania State University.)

A parasite that contributes to larval control of alfalfa weevil in the Black Hills area. Lifesize is about 1/8 inch. Read about SDSU research for alfalfa weevil control plus information about major insect outlook for this year beginning on page 27.



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